
Soil Survey

Ulster County New York

By

A. T. SWEET

United States Department of Agriculture, in Charge

and

WILBER SECOR

Cornell University Agricultural Experiment Station



UNITED STATES DEPARTMENT OF AGRICULTURE
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In cooperation with the
Cornell University Agricultural Experiment Station

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BUREAU OF PLANT INDUSTRY
E. C. AUCHTER, *Chief*
DIVISION OF SOIL SURVEY
CHARLES E. KELLOGG, *Principal Soil Scientist, in Charge*
CORNELL UNIVERSITY AGRICULTURAL EXPERIMENT STATION
C. E. LADD, *Director*
DEPARTMENT OF AGRONOMY
T. L. LYON, *Head*

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SOIL SURVEY OF ULSTER COUNTY, NEW YORK

By A. T. SWEET, Soil Survey Division,¹ Bureau of Chemistry and Soils, United States Department of Agriculture, in Charge, and WILBER SECOR, Cornell University Agricultural Experiment Station

Area inspected by W. J. LATIMER, Acting Inspector, District 1

United States Department of Agriculture in cooperation with the
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¹ The Soil Survey Division was transferred to the Bureau of Plant Industry July 1, 1939.

COUNTY SURVEYED

Ulster County borders the west side of the Hudson River in the southeastern part of the State of New York (fig. 1). Kingston, in the northeastern part of the county, is 85 miles north of New York City and about 50 miles south of Albany. The county is about 40

miles from north to south, its greatest width from east to west is 45 miles, and its area is 1,137 square miles, or 727,680 acres.

Hills and mountains with rather steep slopes comprise approximately two-thirds of the total area. These may be divided into three groups: Marlboro Mountain in the southeastern part; the Shawangunk Mountains in the south-central part; and the Catskill

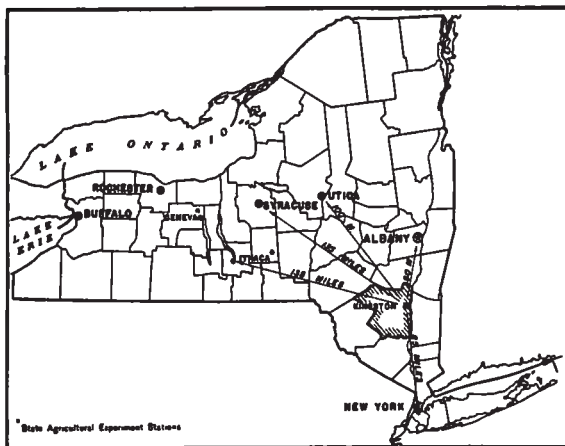


FIGURE 1.—Sketch map showing location of Ulster County, N. Y.

Mountains, which occupy a large area in the central, the western, and the northwestern parts.

Marlboro Mountain is a narrow chain of rather steep and stony hills extending north and south along the Hudson River. At the southern county line they are about 3 miles from the river. This distance becomes less as they extend northward, and is only about 1 mile at Kingston. They range from 1 to about 2 miles in width and have a maximum elevation, west of Highland, of slightly more than 1,100 feet above the river, or tidewater level. North of Rondout Creek they break to a series of hills and ridges, which have the same general northeast-southwest trend.

The Shawangunk Mountains occupy a broad area, ranging from 4 to 6 miles in width, in the south-central part between the valleys of the Wallkill River and Rondout Creek. They extend in a general northeast-southwest direction, the higher part narrowing to the point of termination near Rosendale, beyond which are rough, broken hills. On the southeastern side they form a steep, precipitous bluff, or escarpment, but on the northwestern side the slope is more gradual. The top of this range, in places, is comparatively level or undulating. Its greatest elevation, at Sams Point, is 2,273 feet.

The Catskill Mountains consist of an irregular mountain mass, the greater part of which ranges in elevation between 2,000 and 4,000 feet. From this rise many short, irregular, rounded ridges, and several well-rounded dome-shaped mountains. The highest of these, Slide Mountain, has an elevation of 4,204 feet. The mountain streams occupy deep V-shaped valleys, the sides of which are steep, but in few places, precipitous. The mountain slopes also are steep, ranging

from 500 to 2,000 feet to a mile. Rock outcrop and loose rock masses are common, especially on the steeper slopes, but high, perpendicular cliffs occur in few places. Many of the mountain slopes are covered with soil and support a forest growth.

The Hudson River lies at tidewater level and has practically no flood plain. Two of its tributaries, Esopus Creek and Rondout Creek, together with the Wallkill River, however, are bordered by belts of recently deposited material from which rich alluvial soils have developed. The Wallkill River flows between Marlboro Mountain and the Shawangunk Mountains. Rondout Creek flows between the Shawangunk Mountains and the Catskill Mountains, is joined by the Wallkill River near Rosendale, and enters the Hudson at Rondout. Esopus Creek rises in the Catskills in the western part of the county, supplies water for Ashokan Reservoir, and empties into the Hudson at Saugerties. The flood plains of these streams range from several rods to half a mile or more in width, and they are interrupted in places by steep rocky slopes.

In addition to the recently formed nearly level flood plains there are, in many parts of the county, old high terraces and fragments of eroded terraces, the material of which has been assorted and deposited in layers. The largest and best developed of these are the Rosendale Plains, on which the village of Tillson is situated, the terrace which extends from Kingston northward along the east side of Esopus Valley to Lake Katrine, and the terrace both north and south of Esopus Creek near Saugerties. The elevation of each of these terraces, as well as that of numerous smaller remnants of old terraces, is approximately 200 feet above the Hudson River level, or above sea-level. Other less well-defined terraces and deposits of thinly bedded sand, silt, and clay, which contain rounded gravel in places and range from 200 to 500 or more feet in elevation, are adjacent to Hudson River but high above it, on both sides of Wallkill Valley, along the sides of Rondout Valley, especially on the northern side, between Beaver Kill and the Hudson, in the northeastern part of the county, and elsewhere. Some of this material is in the form of terraces, many of which are severely eroded, some is in the form of dome-shaped mounds, or kames, with intervening kettle-shaped depressions, and, in other places where mountain streams enter the larger valleys, material of this kind has been deposited in the form of alluvial or outwash fans. In the Catskill Mountains the material containing rounded gravel occurs both in the form of kames and outwash fans in places high on the slopes, the highest point noted being on the county line about 5 miles north of Cooper Lake at an elevation of 2,000 feet.

Between the stream valleys or adjacent terraces and the steeper slopes of the mountains are broad belts having an undulating to hilly relief. The most extensive of these lies between Rondout and Esopus Valleys on the south and east and the steeper slopes of the Catskills to the northwest. The northern part of this belt consists of a series of low narrow, but sharp, ridges with a nearly uniform north-northeast trend. Small drainageways extend in the same direction connecting with transverse streams, which have cut through the ridges.

Although almost all of the county lies high above the Hudson River, the land in many places is poorly and imperfectly drained.

Such land includes small areas of muck and swamp, narrow belts along small drainageways, especially in the more nearly level areas, and large tracts on the hill and mountain slopes.

During the last continental invasion of the ice sheet this entire section was covered, and the ice on its retreat left a mantle of till, which ranged in thickness from only a few inches on the mountaintops and hilltops to many feet in the valleys. This till was influenced to some extent by the underlying formations, which included calcareous shale from Marlboro Mountain, Hudson River slates and slaty shale, Shawangunk conglomerate, and both limestone and sandstone in the central and western parts of the county.

Despite the rough and broken relief of this section, the evidence of recent serious erosion is comparatively slight; although some areas consist of thin, shallow, and gullied soils; rock outcrops near the crests of narrow ridges; gullies along terrace edges; and slides of soil and rock material on steep slopes, especially in the mountain valleys, all of which seem to be due, at least in part, to recent or accelerated erosion.

Forest originally covered this entire section, and much of it consisted of heavy stands of timber. Practically all of the land has been cut over—some of it more than once. At present, most of the forest throughout the mountain section is second growth, and extensive areas, which once were farmed, now are abandoned and are overgrown with small trees and underbrush.

White pine is believed to have been common in the original forest, but little of it is now standing. Hemlock bark for tanning once was an important forest product, and good-sized hemlocks still are growing in places. Other forest trees are maple, oak, hickory, ash, beech, birch, locust, wild cherry, yellow poplar, and sycamore, a few black gum, and sassafras. Shrubs and vines include mountain-laurel, rhododendron, azalea, witch-hazel, dogwood, and wild grape. One of the most conspicuous plants of the region is the purple loosestrife, or "rebel weed," as it is commonly called, which grows prolifically on nearly all of the wet and poorly drained areas in the lower lying parts of the county. From June until September such areas can be noted readily by the abundance of reddish-purple spikes of this plant. The grasses include bluegrass, bentgrass, broomsedge, and others. White clover and lespedeza grow where the soil is well supplied with lime.

Ulster County has a very interesting history. Henry Hudson sailed along its eastern shore in 1609. In 1614 a small fort was built at the junction of Rondout Creek and Wallkill River. Settlement was begun at Hurley in 1623 and at New Paltz a little later. The early settlers were largely from Holland, but New Paltz was settled by French Huguenots, who had an important influence in the development of the territory. Ulster was one of the original 12, or "mother counties," into which the State was divided in 1683, and at that time it included all the intermediate settlements of importance on the west bank of the Hudson between New York and Albany.

The first State constitution was adopted at Kingston in 1777. The village was burned by the British in the same year.² The great and permanent attraction at "Sophus," the name by which Kingston was

² SYLVESTER, N. B., and CLEARWATER, A. T. HISTORY OF ULSTER COUNTY, NEW YORK . . . 27 pp., illus. Philadelphia. 1880.

first known, was the broad and extensive areas of "prairie flats" and rich alluvial soils "ready for the plow without the preparatory use of the woodsman's ax."³ For nearly a century it was the producing granary of the Province and is still one of the most intensively cultivated parts of the county.⁴

Water power of the various streams was utilized at an early date. It is thought that the old Du Bois mill, the site of which is near Marlboro, was one of the first mills. Sawmills, gristmills, and carding mills were erected, and numerous small manufacturing plants were established. Many of the early settlers kept Negro slaves. Kingston was incorporated as a village in 1805.

Since its first settlement, Ulster County has supported a number of important industries which since have declined in importance or ceased to exist. In 1828, the Delaware & Hudson Canal from Honesdale, Pa., to Rondout was opened to carry coal from the mines of eastern Pennsylvania to tidewater on the Hudson. It was 107 miles long and had a fall of 585 feet, with 107 locks. The first boats were small, carrying only 28 tons, and were drawn by 1 horse. Ten days were required for a round trip. In 1834, 500,000 tons of coal were carried through this canal, which long since has been abandoned, but stretches of the old canal and numerous locks may yet be seen in many places in the county.

Construction of the Delaware & Hudson Canal led to the manufacture of native or natural rock cement at Rosendale, begun in 1826. It was noticed that the lime from certain strata of the lower Helderberg formation near Rosendale hardened under water instead of slacking, and soon the manufacture of natural rock cement became an important industry. When this industry was at its height, a dozen or more plants employed over 5,000 men. Production increased rapidly, and in 1892 the annual output was 2,833,107 barrels of cement. Soon afterward, the Rosendale cement came into competition with portland cement, manufactured by a cheaper process, and the business rapidly declined.

During its early development Kingston had an important river-freight business. The Cornell Steamboat Co. became one of the most important steam-towing lines in the United States. At first, passengers were carried to New York on sailing vessels, a trip of 2 or 3 days. Later, steamboats ran on regular schedule between Kingston and New York in 12 hours. The time required for this trip was reduced later to 5 hours.

In 1836 the first flagstone quarry was opened in Ulster County, and the business developed until the annual output amounted to millions of dollars. So important was this for many years that bluestone from this county now covers the walks and forms the sills and lintels of doors and windows in many cities. Owing to the extensive use of cement, quarrying has declined, but it is still carried on, crushed stone for road building being the principal product.

This county is well supplied with transportation facilities. The Hudson River transportation is important. The West Shore Railroad, New York, Ontario, & Western Railway, and the Ulster & Delaware Branch of the New York Central Railroad offer ample ship-

³ SCHOONMAKER, M. HISTORY OF KINGSTON, NEW YORK. 558 pp., illus. New York. 1888.

⁴ From the type of soil in the Esopus Valley near Kingston, it is believed that this was not a "prairie," or open grassland, at the time of first white settlement, but that it had probably been cleared and cultivated by the Indians.

ping facilities. There is also an excellent system of highways over which the principal agricultural products are shipped by truck. Fruit, vegetables, and other farm products may be loaded in the evening and be on the New York City markets early the next morning, thus giving producers of this section an important advantage over those of nearly every other section of the country.

Ulster County in 1930 had a population of 80,155, of which 28,088 lived in Kingston and 3,000 more very near the city limits. Kingston has at present 92 industrial establishments employing between 4,000 and 5,000 people. These include shirt factories, cigar factories, brick-manufacturing plants, boat-building shops, wood-working plants, silk-manufacturing plants, road-machinery factories, and others. There are also several wholesale groceries, lumberyards, and oil companies. Other villages of importance are Saugerties, Highland, and Milton, on the Hudson; New Paltz, the seat of a State normal school, Ellenville, and Kerhonkson, in the southwestern part of the county; and Phoenicia and Woodstock, in the northern part.

An important change in the population of Ulster County is now in progress and has been for some time. Many farms have been abandoned for farming purposes, and the residences have been converted into hotels and boarding houses for summer boarders. Other farms have been taken over by the State, either through purchase or default in the payment of taxes, and made into forest reserves, or they have been purchased by wealthy people for country homes or hunting and fishing preserves. The second change is the movement of city people of moderate means into the country, each of whom owns a few acres and an inexpensive home where the family may live during a part or all of the year. The head of the family makes the living by work in the city or in some nearby village. Many inexpensive summer homes have also been built.

CLIMATE

Ulster County has an equable climate well suited for the agricultural activities carried on. Extremes of temperature are not marked, especially near the Hudson River and in the lower parts of the county where most of the farms are located. The tempering influence of this large body of water has made possible the successful growing of apples, peaches, pears, and other fruits in a belt several miles wide along the river. These fruits can be grown also at higher altitudes farther from the river, but, on account of the greater danger of extreme cold in winter and of late killing frosts in spring, crops are much less certain. Some of these higher, cooler parts of the county offer possibilities for growing cauliflower, lettuce, and potatoes, although little of the land is utilized for such crops, the principal areas so used being in Hardenburg Town in the northwestern part of the county.

Rainfall is abundant, if well conserved, for all crops grown. It is fairly evenly distributed throughout the year, but is slightly heavier in summer than in any other season. The mean annual precipitation at Mohonk Lake is 45.90 inches. November is the driest month. The average date of the last killing frost is April 27 and that of the first is October 18, giving a normal growing season of 174 days. Frost has occurred, however, as late as May 16 and as early as September 19. The average depth of snowfall is 61.1 inches.

Table 1 gives the more important climatic data as recorded by the United States Weather Bureau station at Mohonk Lake.

TABLE 1.—Normal monthly, seasonal, and annual temperature and precipitation at Mohonk Lake, Ulster County, N. Y.

[Elevation, 1,245 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1930)	Total amount for the wettest year (1902)	Snow, average depth
	° F.	° F.	° F.	Inches	Inches	Inches	Inches
December.....	27.7	63	-24	3.64	1.84	6.86	12.6
January.....	26.4	65	-17	3.38	1.22	3.44	16.5
February.....	24.2	68	-20	3.49	1.15	4.32	15.4
Winter.....	28.1	68	-24	10.51	4.21	14.62	44.5
March.....	36.5	80	-8	3.71	1.67	6.32	11.0
April.....	45.7	88	5	4.00	.97	4.09	2.7
May.....	57.4	91	23	3.63	3.76	2.78	(¹)
Spring.....	46.5	91	-8	11.34	6.40	13.19	13.7
June.....	65.1	95	33	3.93	4.34	5.57	0
July.....	69.8	96	43	4.49	2.81	9.75	0
August.....	67.5	94	39	4.82	4.58	2.86	0
Summer.....	67.5	96	33	13.24	11.73	18.18	0
September.....	61.5	93	28	4.08	3.47	7.69	0
October.....	50.4	84	19	3.59	1.08	5.90	(¹)
November.....	40.3	72	3	3.14	4.51	1.17	2.9
Fall.....	50.7	93	3	10.81	9.06	14.76	2.9
Year.....	47.7	96	-24	45.90	31.40	60.75	61.1

¹ Trace.

At West Point, Orange County, which is only a few miles south of the Ulster County line, the mean annual temperature is 50.5° F. as compared with 47.7° at Mohonk Lake, the range in temperature is from 106° to -17°, and the mean annual precipitation is 42.22 inches. The average length of the growing season is slightly longer—190 days. The records at this station are believed to be more nearly representative of weather conditions in the eastern and more important agricultural parts of Ulster County than are the records at Mohonk Lake. Thus, in the eastern part of the county the temperature is slightly higher both in summer and winter, the average rainfall is slightly lower, and the growing season is longer.

These variations in climatic conditions have an important influence in the development of the county. The longer growing season and higher normal temperature of the eastern part have favored commercial fruit growing, poultry raising, and dairying. On the other hand, the higher altitudes, cooler climate, interesting vegetation, and beautiful scenery of the hills and higher mountains appeal to summer tourists and to persons wishing to establish summer homes.

AGRICULTURAL HISTORY AND STATISTICS

Early in the development of the county, cereals were brought by oxcart from Hurley, Marbletown, and New Paltz to Kingston and shipped by sloop to New York, together with packs of dressed deer

and fox skins. There seems to be but scant record of other crops grown, but it may safely be assumed that they included corn, grown extensively by the Indians, and melons. Apple trees are known to have been planted by many early New York settlers and by the Indians.

Many thousands of acres once farmed are now abandoned for farm use. Such areas can still be recognized with a fair degree of accuracy by the old stone fences which surround them, by remnants of old orchards and clumps of lilac and other shrubs, or by the character of the forest growth they support. Some of them have been lying idle for 50 years or more, but many have been farmed more recently. Land included in farms in 1880 totaled 540,736 acres, or 74.3 percent of the county, of which 305,996 acres were improved; whereas the land included in farms in 1935 totaled 314,414 acres, or 43.2 percent of the county, of which 138,655 acres were improved. The average size of the 5,914 farms in 1880 was 98 acres; the average size in 1935 was 83.3 acres, and the number of farms was only 3,774.

Table 2, compiled from the United States census reports, gives the acreage of the more important farm crops for each census year for the last 55 years, and from these the changes and the general trend in crop production may be noted.

TABLE 2.—*Acreage of the principal crops in Ulster County, N. Y., in stated years*

Crop	1879	1889	1899	1909	1919	1929	1934
	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>
Corn.....						8,404	10,466
For grain.....	19,237	12,960	15,588	12,421	11,222	3,858	4,359
For silage, fodder, etc.....					13,525	4,546	6,107
Oats, threshed.....	17,027	14,918	9,786	9,583	9,949	2,048	2,382
Wheat, threshed.....	3,194	1,467	1,806	1,305	4,670	1,421	1,585
Rye, threshed.....	18,710	11,844	10,530	6,905	4,582	517	390
Buckwheat, threshed.....	10,893	6,239	7,567	4,819	3,823	520	(¹)
Hay.....	92,078	95,205	83,375	81,182	63,613	53,407	54,672
Alfalfa.....			1	98	405	1,195	1,013
Timothy and clover, alone or mixed.....				60,731	42,060	39,531	39,260
Sweetclover.....						47	396
Small grains for hay.....			1,018	584	1,200	762	752
Legumes for hay.....					118	74	77
Other tame hay.....			82,266	18,026	18,890	11,152	13,174
Wild hay.....			90	843	970	640	
Potatoes.....	5,901	4,619	4,807	4,282	3,878	1,197	1,334
Vegetables (other than potatoes).....				2,346	1,026	2,029	2,987
	<i>Trees</i>	<i>Trees</i>	<i>Trees</i>	<i>Trees</i>	<i>Trees</i>	<i>Trees</i>	<i>Trees</i>
Apples.....		251,329	347,497	240,933	271,863	328,443	413,656
Peaches.....		120,449	480,767	313,971	167,380	126,223	91,526
Pears.....		39,895	107,374	85,392	187,635	142,688	119,481
Plums and prunes.....		7,474	16,932	24,138	11,798	6,316	8,429
Cherries.....		9,051	16,263	11,005	22,273	20,554	35,088
	<i>Vines</i>	<i>Vines</i>	<i>Vines</i>	<i>Vines</i>	<i>Vines</i>	<i>Vines</i>	<i>Vines</i>
Grapes.....			2,063,493	969,301	2,108,333	2,981,262	2,663,024
	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>
Strawberries.....			720	895	548	328	753
Blackberries and dewberries.....			150		114	17	(¹)
Raspberries and Logan blackberries.....							(¹)
Currants.....			410	707	867	159	(¹)
			1,240		1,382	733	(¹)
	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Maple sugar.....	43,760	32,719	9,100	18,025	7,381	722	(¹)
	<i>Gallons</i>	<i>Gallons</i>	<i>Gallons</i>	<i>Gallons</i>	<i>Gallons</i>	<i>Gallons</i>	<i>Gallons</i>
Maple sirup.....	3,647	2,455	3,156	12,338	9,348	1,854	(¹)

¹ Cut for forage only.

² Not reported.

³ Includes wild hay.

Corn for grain, the crop of largest acreage, except hay, decreased from 19,237 acres in 1879 to but little more than one-fifth of this acreage in 1934. The acreage of corn for silage, fodder, and other purposes now exceeds the acreage of corn for grain. Oats were harvested for grain from 17,027 acres in 1879 and from 2,382 acres in 1934. Oats were cut and fed unthreshed, however, from 2,175 acres in 1934. The acreage in wheat was 3,194 acres in 1879 and 1,585 acres in 1934. The slight increase in acreage of both oats and wheat in 1919 doubtless was due to higher prices following the World War. The decrease in the acreage of rye is marked—from 18,710 acres in 1879 to 380 acres in 1934. Barley has never been an important crop. Buckwheat was grown on 10,893 acres in 1879 and on only 520 acres in 1929. The acreage in hay has fluctuated less than that of most other crops and was about two-thirds as large in 1934 as in 1879. Potatoes decreased from 5,901 acres in 1879 to 1,334 acres 55 years later. Hops were grown on a very small acreage in 1879, but none has been reported since 1899. The production of maple sugar and sirup, which was of considerable importance in the past, is now of little significance.

In contrast with these crops of decreasing importance are others in which production for several years has remained comparatively stable or in which there has been an increase. Neither alfalfa nor clover were reported prior to 1900, but since that time there has been a constant, although slow, increase in the acreage of both crops. The chief crops of increasing importance are apples and grapes. Crops of less importance are cherries, plums, and vegetables other than potatoes. The production of pears and peaches, although still important, has declined. Of the vegetables, sweet corn and tomatoes occupy the largest acreages. Cauliflower, lettuce, cabbage, and brussels sprouts are grown to rather limited extent in the higher northwestern parts of the county and to some extent in other localities.

The shift in crop production has been accompanied by an important change in character of the population. The early agriculture was based on the production of general farm crops and the raising of livestock. The farm homestead consisted of an orchard and garden, and the farms supported a sparse rural population, largely descendants of the early pioneers. Only a small proportion of the present farm population is of pioneer stock. The commercial production of fruit and truck crops has largely replaced general farming on the more desirable land, especially in the south-central part of the county, along the Hudson River, and in the valleys and benchlands along the smaller streams, which were the sections first settled by the pioneers. The less desirable farm land, on the other hand, has been abandoned and has been taken over by the State and by individuals who are not dependent on agriculture for a livelihood.

Aside from fruit and vegetable growing, the two most important agricultural occupations are poultry raising and dairying. Ulster County is one of the three most important egg- and poultry-producing sections of the United States. This is due, in part, to favorable climatic conditions and to the proximity of New York City and other markets. The number of chickens reported in 1930 was 471,781, valued at \$537,830; and in 1929 the quantity of eggs produced was 4,217,835 dozen, valued at \$471,292. A slight decline is reported by the 1935 census, the number of chickens being 452,307 and the quantity of eggs

produced in 1934 being 3,979,537 dozen. The county also maintains a number of good dairy herds, in which the more important dairy breeds are represented. The number of cattle reported in 1930 was 24,853, valued at \$2,115,583, of which the larger number were dairy cows, and the production of milk in 1929 totaled 9,376,943 gallons. Although the number of cattle decreased slightly to 23,454 in 1935, the production of milk in 1934 represented an increase over that in the previous census, being 9,503,902 gallons.

There was an increase in the number of horses from 4,198 to 4,307 between the census years 1930 and 1935, and a decrease in the number of hogs from 3,910 to 2,133.

Tractors are used to a considerable extent on the larger farms, but much of the work of plowing and cultivation is done by horses. Much hand labor is used on the fruit farms and truck gardens. Both commercial fertilizer and lime are used on the more intensively cultivated lands.

Of the 314,414 acres in farms in 1935, 95,786 acres represented land from which crops were harvested; 3,071 acres, land on which they were a failure; 16,608 acres, idle or fallow land; 80,719 acres, pasture land; 95,192 acres, woodland not pastured; and 23,038 acres, all other land in farms. The proportion of tenancy is small. According to the 1935 census, owners operate 91.6 percent of the farms, tenants 7 percent, and managers 1.4 percent.

SOIL-SURVEY METHODS AND DEFINITIONS

Soil surveying consists of the examination, classification, and mapping of soils in the field.

The soils are examined systematically in many locations. Test pits are dug, borings are made, and exposures, such as those in road or railroad cuts, are studied. Each excavation exposes a series of distinct soil layers, or horizons, called, collectively, the soil profile. Each horizon of the soil, as well as the parent material beneath the soil, is studied in detail; and the color, structure, porosity, consistence, texture, and content of organic matter, roots, gravel, and stone are noted. The reaction of the soil⁵ and its content of lime and salts are determined by simple tests.⁶ Drainage, both internal and external, and other external features, such as relief, or lay of the land, are taken into consideration, and the interrelation of soils and vegetation is studied.

The soils are classified according to their characteristics, both internal and external, special emphasis being given to those features influencing the adaptation of the land for the growing of crop plants, grasses, and trees. On the basis of these characteristics soils are grouped into mapping units. The three principal ones are (1) series, (2) type, and (3) phase. Areas of land, such as coastal beach or bare rocky mountainsides that have no true soil, are called (4) miscellaneous land types.

The most important group is the series, which includes soils having the same genetic horizons, similar in their important characteristics

⁵ The reaction of the soil is its degree of acidity or alkalinity expressed mathematically as the pH value. A pH value of 7 indicates precise neutrality, higher values indicate alkalinity, and lower values indicate acidity.

⁶ The total content of readily soluble salts is determined by the use of the electrolytic bridge. Phenolphthalein solution is used to detect a strong alkaline reaction.

and arrangement in the soil profile, and developed from a particular type of parent material. Thus, the series includes soils having essentially the same color, structure, and other important internal characteristics and the same natural drainage conditions and range in relief. The texture of the upper part of the soil, including that commonly plowed, may vary within a series. The soil series are given names of places or geographic features near which they were first found. Thus, Cossayuna, Dutchess, Hoosic, Agawam, and Hudson are names of important soil series in this county.

Within a soil series are one or more soil types, defined according to the texture of the upper part of the soil. Thus, the class name of the soil texture, such as sand, loamy sand, sandy loam, loam, silt loam, clay loam, silty clay loam, and clay, is added to the series name to give the complete name of the soil type. For example, Hudson silt loam and Hudson silty clay loam are soil types within the Hudson series. Except for the texture of the surface soil, these soil types have approximately the same internal and external characteristics. The soil type is the principal unit of mapping, and because of its specific character it is usually the soil unit to which agronomic data are definitely related.

A phase of a soil type is a variation within the type, which differs from the type in some minor soil characteristic that may have practical significance. Differences in relief, stoniness, and the degree of accelerated erosion frequently are shown as phases. For example, within the normal range of relief for a soil type, there may be areas that are adapted to the use of machinery and the growth of cultivated crops and others that are not. Even though there may be no important difference in the soil itself or in its capability for the growth of native vegetation throughout the range in relief, there may be important differences in respect to the growth of cultivated crops. In such an instance, the more sloping parts of the soil type may be segregated on the map as a sloping or a hilly phase. Similarly, soils having differences in stoniness may be mapped as phases, even though these differences are not reflected in the character of the soil or in the growth of native plants.

The soil surveyor makes a map of the county or area, showing the location of each of the soil types, phases, and miscellaneous land types, in relation to roads, houses, streams, lakes, section and township lines, and other local cultural and natural features of the landscape.

SOILS AND CROPS

The soils of Ulster County, like those of other parts of northeastern United States, have certain properties in common. They are known as Gray-Brown Podzolic soils, which are soils formed under an abundant rainfall and a luxuriant growth of forest composed largely of deciduous or hardwood trees. The more soluble compounds are largely leached out. The soils range from slightly to strongly acid in the upper part and, with a few exceptions, are only slightly less acid in the lower part of the subsoils. The undisturbed forest land has a layer of leaf litter, or duff, on the surface; but there is little organic matter in most of the soils, especially after they have been under cultivation for a period of years.

The color profile varies according to drainage conditions. Where well drained, the surface soils are brown, light brown, or slightly reddish brown, and the subsoils are not mottled. Where imperfectly or poorly drained, the surface soils are dark gray, dark grayish brown, or nearly black, and the subsoils are mottled with light gray and rusty brown.

Certain broad natural features of the soils and of the landscapes in which they exist may be used in making a natural soil classification. These characteristics influence the productivity and the use of the land, and the natural groups correspond in a general way to use groups. For the purpose of facilitating discussion the soils and land types have been classified in four natural groups as follows: (1) Soils of the uplands, hills, and mountains, developed from stony or gravelly glacial till and residual materials; (2) soils of the terraces and outwash fans, developed from stratified water-laid materials; (3) soils of the flood plains and of low-lying imperfectly and poorly drained areas; and (4) miscellaneous land types.

In the following pages the soils of the county are described in detail and their agricultural relationships are discussed; their location and distribution are shown on the accompanying soil map; and their acreage and proportionate extent are given in table 3.

TABLE 3.—*Acreage and proportionate extent of the soils mapped in Ulster County, N. Y.*

Soil type	Acres	Per-cent	Soil type	Acres	Per-cent
Cossayuna gravelly loam.....	24,832	3.4	Hudson silt loam, imperfectly drained phase.....	4,224	0.6
Cossayuna gravelly loam, deep phase.....	2,176	.3	Hudson silt loam, rolling phase...	1,408	.2
Cossayuna gravelly loam, shallow phase.....	24,704	3.4	Hudson silty clay loam.....	1,088	.1
Cossayuna sandy loam.....	1,216	.2	Hudson silty clay loam, broken phase.....	1,088	.1
Dutchess gravelly loam.....	3,968	.5	Hudson very fine sandy loam.....	832	.1
Nassau slate loam.....	6,592	.9	Schoharie silty clay loam.....	7,936	1.1
Nassau slate loam, steep phase.....	2,560	.4	Tioga silt loam.....	2,688	.4
Farmington gravelly loam.....	12,288	1.7	Tioga fine sandy loam.....	3,712	.5
Catskill gravelly loam.....	14,016	1.9	Barbour silt loam.....	10,432	1.4
Catskill stony loam.....	42,816	5.8	Barbour loamy sand.....	3,008	.4
Albia gravelly loam.....	12,032	1.7	Barbour gravelly sandy loam.....	7,936	1.1
Wurtsboro gravelly sandy loam.....	9,408	1.3	Barbour loam.....	2,624	.4
Culvers fine sandy loam.....	21,056	2.9	Middlebury silt loam.....	3,456	.5
Culvers stony fine sandy loam.....	20,736	2.9	Holly silt loam.....	8,320	1.1
Culvers gravelly loam.....	21,760	2.9	Holly sandy loam.....	2,048	.3
Culvers stony loam.....	15,168	2.1	Mansfield silt loam.....	18,048	2.5
Lackawanna silt loam.....	12,928	1.8	Mansfield gravelly loam.....	2,880	.4
Walton gravelly silt loam.....	12,864	1.8	Livingston silty clay loam.....	1,664	.2
Hoosic gravelly loam.....	14,784	2.0	Boynton silt loam.....	2,880	.4
Agawam sandy loam.....	6,720	.9	Norwich loam.....	17,024	2.3
Agawam loamy fine sand.....	4,608	.6	Orono silty clay loam.....	4,864	.7
Agawam loamy fine sand, rolling phase.....	2,496	.3	Poygan silty clay loam.....	2,176	.3
Merrimac gravelly sandy loam.....	448	.1	Braceville silt loam.....	576	.1
Otisville gravelly loam.....	12,544	1.7	Basher silt loam.....	896	.1
Otisville sandy loam.....	2,624	.4	Muck.....	7,424	1.0
Chenango gravelly loam.....	9,536	1.3	Riverwash.....	512	.1
Tunkhannock gravelly loam.....	2,368	.3	Made land.....	448	.1
Tunkhannock gravelly loam, rolling phase.....	512	.1	Rough stony land.....	61,568	8.5
Tunkhannock gravelly loam, alluvial-fan phase.....	3,584	.5	Rough mountainous land (Culvers soil material).....	212,928	29.3
Hudson silt loam.....	11,048	1.6	Total.....	727,680	

SOILS OF THE UPLANDS, HILLS, AND MOUNTAINS DEVELOPED FROM STONY OR GRAVELLY GLACIAL TILL AND RESIDUAL MATERIALS

Soils of the uplands, hills, and all but the higher mountains, developed from stony or gravelly glacial till and residual materials are Podzols. They are characterized by brown, light-brown, reddish-brown, or deep Indian-red surface soils. The upper part of the subsoil, below plow depth, is slightly lighter in color, and the lower part of the subsoil is free or nearly free from mottlings of light gray and rusty brown. Sharp rock fragments and larger stone masses are present in abundance in the subsoil and substratum and, to slightly less extent, in the surface soil. Much of this material consists of a thin deposit of glacial till, in which some of the gravel is rounded, but most of the gravel is sharp and angular. Unweathered bedrock lies, in many places, at a slight depth.

Because of the steepness of the slopes on which most of these soils occur, the removal of the surface soil by erosion is constant, and the underlying less weathered soil material is exposed on the surface or is partly uncovered. The soils have had no opportunity to advance beyond a youthful stage of development. They are, for this reason, closely related to the parent soil material, which, in turn, is related to the underlying bedrock or the rocks from which the till was derived.

In places where the relief is smooth and the fine soil material is deep, these soils are fairly well adapted to general farming and market gardening, and many areas, especially in the eastern part of the county, are well adapted to fruit growing; but in places where the relief is mountainous, steep, and rough, and the soils are very stony, gravelly, or shallow, the only efficient uses of the land are for grazing and forestry.

Soils of the Cossayuna series are the most important of this group. They are brown to grayish brown, and are slightly acid. Much of the larger surface gravel and many of the stones in the stone fences are bluish gray inside and contain lime carbonate. The underlying rock formations and stone masses at or near the surface consist of the heavy bedded calcareous sandstone of Marlboro Mountain and, in places south of New Paltz, of a dark-gray calcareous slate. These soils cover the best developed parts of the hilly section in the eastern and southeastern parts of the county and are extensively used for orchards and for growing grapes, other small fruits, and general farm crops, such as small grains, corn, and grasses.

Soils of the Dutchess series are light brown or pale yellowish brown, slaty and shaly and, in most places, are shallow. They are underlain by noncalcareous shale or slate. The Dutchess soils are slightly lighter in color and a little more strongly acid in reaction than the soils of the Cossayuna series.

Soils of the Nassau series closely resemble those of the Dutchess series, but, as a rule, they are not so deep and have numerous outcrops, on ridges and steep slopes, of slate or shale.

The Farmington soils are slightly deeper brown or reddish brown than the Cossayuna or Dutchess soils and are underlain, in many places, at slight depths by thick massive beds of pure limestone. Sharp edges of tilted bedrock are exposed at the surface in many places, as at Stone Ridge. A somewhat broken belt of Farmington gravelly loam, the only type of the series mapped in this county,

extends from Rosendale through Kingston to the north and northeast beyond the county line.

Soils of the Catskill series are brown or slightly reddish brown, gravelly, and stony. The subsoil is not very compact. It is underlain at a slight depth by bedrock of various kinds, mostly hard thin-bedded noncalcareous sandstone.

Soils of the Albia series are brown or grayish brown. They contain considerable quantities of crystalline gravel and large masses of Shawangunk conglomerate, and they have a well-compacted layer in the subsoil.

Soils of the Wurtsboro series are developed on comparatively shallow compact till mainly of quartzitic material. They are yellowish brown, contain much gravel, and have a well-compacted layer in the deep subsoil. Only one type, Wurtsboro gravelly sandy loam, is mapped.

Soils of the Culvers series are grayish brown or reddish brown and have a well-compacted layer in the subsoil. They are underlain by olive-gray or reddish-brown thin-bedded sandstone and have abundant fragments of the same material on the surface and through the surface soil and subsoil. There is but slight indication of glacial influence. Most of the Culvers soils as mapped include some well-drained Catskill soils which were not separately mapped because much of the land is to be used for public purposes and will not be cultivated.

Soils of the Lackawanna series are deep Indian red and are associated with the developed from the weathered products of a soft shale and thin-bedded sandstone of the same color. Small areas, surrounded by areas of the Culvers soils, are developed on the high slopes of the Catskill Mountains, and the change from the reddish-brown color of the Culvers soils to the darker Indian-red color of the Lackawanna soil is gradual.

Walton gravelly silt loam, the only Walton soil mapped in this county, consists of dark-brown gravelly finely granular silt loam. It occupies valley slopes and low drumlinlike formations.

Cossayuna gravelly loam.—Cossayuna gravelly loam is, as a whole, the most highly productive soil of the uplands or hills of this section. Numerous areas lie between the Wallkill Valley and the Hudson River, from Kingston southward.

In cultivated fields, the surface soil consists of brown or grayish-brown loose and friable gravelly loam, which is easy to cultivate. Below a depth of 7 or 9 inches, or the average plow depth, this material grades into a lighter or more yellowish brown heavier textured gravelly material. When dry, this material breaks into small sharp clods, which crumble readily. In most places, at a depth ranging from 24 to 30 inches, is more gravelly or stony loam, which is not compact or only slightly so. Depth to bedrock ranges from only 3 to many feet. The reaction is acid in the surface soil, becomes less acid with depth, and is neutral at a depth of 30 inches.

The principal variations in this soil are in the quantity of gravel on the surface and in the thickness of the subsoil. In most places the quantity of gravel is not sufficient to interfere seriously with the cultivation or production of crops. In some places, however, the gravelstones are large and very abundant. The depth to the subsoil

and substratum is an important factor, especially where the land is to be planted to orchards. For best results, orchards should be planted where the soil mantle over bedrock is from 3 to 6 feet or more thick.

Included on the soil map are areas of soils, which differ from the typical soil but are too small to be differentiated on a map of the scale used. In some of these areas, bedrock is at or very near the surface. Other areas of low-lying imperfectly drained soils, can be recognized by their darker surface soils and by a mottling of light gray and rusty brown in the subsoils. Still other areas consist of gravelly silt loam or gravelly clay loam, which, owing to the content of fine gravel and a rough feel, resembles loam in tilth and adaptation to crops. South and west of Lattintown is an area in which the subsoil is darker yellowish brown than that of the typical soil, but the land has about the same value.

Cossayuna gravelly loam is used for the production of nearly all crops common to the section, for dairying, and, where the soil mantle is thick, for the production of apples and other tree fruits. The application of lime is beneficial and, in places, necessary for the successful production of clover, alfalfa, and other legumes. The larger part of this land is under cultivation. Corn yields from 35 to 45 bushels an acre; oats, 25 to 45 bushels; wheat, 15 to 20 bushels; rye, 12 to 18 bushels; clover, 1 to 1½ tons; alfalfa, 1½ to 2 tons; and potatoes, 60 to 125 bushels.

Cossayuna gravelly loam, deep phase.—The deep phase of Cossayuna gravelly loam differs from the typical soil principally in the greater depth to the subsoil and substratum. It is closely associated with the typical soil and occurs in places as small low ridges or drumlins of glacial till, in some of which rounded or water-worn gravel is present. There is less gravel on the surface than on the typical soil. The same crops are grown, as on the typical soil, but the deeper soil is a little more productive. All the land is under cultivation.

Cossayuna gravelly loam, shallow phase.—Cossayuna gravelly loam, shallow phase, occupies areas in which a large part of the soil is very shallow, the soil covering over much of the area being only a few inches thick. The bare rock is exposed in many places. Between the areas of shallow soil and rock outcrops are other areas, in most places too small to be outlined on a small-scale map, in which the soil material is sufficiently thick to produce fair yields of crops. Many of these small areas of thicker soil are used for cultivated crops, and the larger areas of shallow soil are used for grassland.

The areas indicated on the map by stone symbols differ from the rest of this shallow soil in that only about 15 percent or less of the surface may be used for grassland or for cultivation. The remainder is very rough and stony, has but small value even for forestry, and differs from rough stony land only in that it contains very small scattered areas of tillable land.

Soil of the shallow phase is closely associated with the typical soil. One of the most extensive bodies is between Kingston and the highway from New Paltz to Highland, and some are on the slopes of Marlboro Mountain. It is estimated that from 15 to 45 percent of this shallow soil is of some value for cultivated crops or is fair grassland. Yields are low, ranging from 10 to 20 bushels of corn an acre, 10 to 15 bushels of oats, and 8 to 12 bushels of wheat.

Cossayuna sandy loam.—Cossayuna sandy loam is similar to typical Cossayuna gravelly loam or the shallow phase of that type. The greater part of it is shallow, but it has a thin surface covering of loamy fine sand. For the most part, areas of this soil adjoin or are near the border of stream valleys or terraces, and it seems probable that the sand has been blown from the valleys and terraces up over the uplands. Some of this land is under cultivation and is used largely for truck and garden crops, but the larger part is in forest. The total extent is small, and the agricultural value, generally, is lower than that of Cossayuna gravelly loam. The largest areas are in the vicinity of Ulster Park, south of Kingston.

Dutchess gravelly loam.—Dutchess gravelly loam, to a depth of about 7 inches, is light-brown or grayish-brown finely granular gravelly loam, the gravel consisting of small sharp slate or shale fragments. Below this is pale yellowish-brown gravelly loam extending to a depth of 15 inches, below which is darker yellowish-brown heavy gravelly loam or silt loam. At a depth ranging from 24 to 30 inches is very gravelly partly disintegrated slate or shale.

A few small areas of this soil occur near the Hudson River in the southeastern part of the county and on the Shawangunk Mountains south of Ellenville.

Other areas in the vicinity of New Paltz and southward, which, on account of slate and shale fragments in the soil and beds of the same material at slight depths, have the appearance of Dutchess soils, are included in mapping with the Cossayuna soils because the slate and shale are calcareous, effervescing freely on the application of acid, although analyses show the soil to contain only a small quantity of carbonate of lime, less than 6 percent in a typical sample that was analyzed.

Where the soil is sufficiently deep, it is well suited to tree fruits, grapes, and other small fruits, but much of it is shallow or has shallow ridges through it. Acre yields are as follows: Corn, from 20 to 35 bushels; wheat, 12 to 15 bushels; oats, 25 to 35 bushels; buckwheat, 12 to 15 bushels; clover, 1 to 1½ tons; alfalfa, 1½ to 2 tons; and potatoes, 50 to 140 bushels.

Nassau slate loam.—The surface soil of Nassau slate loam is brown or pale yellowish-brown finely granular gravelly loam, the gravel consisting of thin slate and shale fragments. Below a depth of about 6 inches is a slightly lighter brown slaty loam which extends to a depth of about 12 inches where it grades into yellowish-brown very slaty loam. Below this, at various depths, is partly disintegrated bluish-gray or olive-gray slate and shale. The reaction of the surface soil is moderately acid, and that of the subsoil is slightly acid. Areas are included, in which the soil is slightly heavier and more silty than is typical; also some stony areas, in which many ridges of slate or shale are exposed at the surface. The included areas are used in the same way as is the typical soil, but the stony areas have a lower value for crops than the rest of the soil mapped as Nassau slate loam.

Nassau slate loam occurs mainly in small areas having a very hilly relief, principally in the southeastern part of the county near the Hudson. Erosion is a serious problem.

The land is used to some extent for orchards. Trees make a fair growth and produce well where the soil is sufficiently deep, but they

do not do well where it is very shallow. Grapes, currants, and other small fruits are grown extensively.

Nassau slate loam, steep phase.—The steep phase of Nassau slate loam occurs on slopes too steep for cultivation. Its value, even for grassland or for forestry, is slight. It differs from the typical soil in its slighter depth, ranging from only a few to 12 inches in thickness over the parent slate or shale. The only area mapped is east of Mohonk Lake.

Farmington gravelly loam.—Farmington gravelly loam is dark-brown to slightly reddish-brown finely granular loam to a depth of about 7 inches, where it is underlain by pale reddish-brown heavier textured gravelly loam, with a small-clod structure. At an average depth of about 15 inches, the material changes to lighter reddish-brown very gravelly loam which, where the soil is well developed, extends to a depth of 24 to 36 inches.

Northeast of Stone Ridge and Rosendale, near Cottekill, and elsewhere are areas in which rock outcrops are few and in which most of the soil is fairly deep. These areas are well suited to all crops grown in this part of the county, and, owing to the presence of lime in the subsoil, are especially well suited for grassland. Much of this soil, however, is shallow, and in some places the soil covering is entirely absent. The areas on crests of ridges underlain by limestone, which extend north of Kingston to the county line, are of this type.

Where this soil is less than 12 or 15 inches deep, its best use is for grassland, but the deeper areas may be used for cultivated crops. For orchards the depth should not be less than 30 inches, and greater depth is desirable. Corn yields 25 to 30 bushels an acre on this soil; wheat, 12 to 15 bushels; oats, 15 to 30 bushels; buckwheat, 12 to 18 bushels; clover, $1\frac{1}{2}$ tons; alfalfa, $1\frac{1}{2}$ to 2 tons; and potatoes, 50 to 100 bushels.

In the vicinity of Hurley, in the eastern part of the city of Kingston, and in a few other places are areas with a surface covering of sand, from 6 to 10 or more inches thick. This is probably the result of wind erosion, by which sand was carried from the valley and deposited over the adjacent uplands. In places, these sandy areas are used for garden and truck crops.

Catskill gravelly loam.—Catskill gravelly loam is dark and slightly reddish brown finely granular gravelly loam to a depth of about 5 inches. In forested areas much of the soil has a surface mineral layer, 2 or 3 inches thick, of light-gray gravelly loam. Below this is reddish-brown heavier gravelly loam or silt loam, with a small-clod structure, extending to a depth of 10 or 12 inches, where it grades into a slightly more friable lower subsoil layer. At a maximum depth of 18 inches this rests on bluish-gray hard noncalcareous sandstone. The soil mantle in many places, however, is only a few inches thick. The quantity of gravel and stones on the surface also varies widely. Cultivated areas, from the surface of which many of the stones have been removed, are included with this soil on the map, although parts of these areas are very stony and the soil is a stony loam rather than a gravelly loam.

Only a small part of typically developed Catskill gravelly loam is under cultivation. Corn yields from 5 to 15 bushels an acre on this soil; wheat, 6 to 10 bushels; oats, 8 to 15 bushels; clover, one-half to

three-fourths ton; and potatoes, 25 to 50 bushels. Many areas, once farmed, are abandoned and support a forest growth, in which black oak predominates in places.

Catskill stony loam.—Catskill stony loam consists of reddish-brown friable gravelly loam, ranging from only a few inches to 12 inches in thickness. In many places the soil has a 2- or 3-inch mineral soil layer of pale-gray gravelly stony loam. It includes numerous large areas, in which the bedrock entirely lacks a soil covering. Rock outcrops, ledges, and masses of large loose stones are common. These rock masses, for the most part, consist of bluish-gray very hard thin-bedded sandstone, which has been extensively quarried and used for building purposes and for flagstones. It is still quarried to some extent, but its principal use at present is for road building. The greater part of this blue sandstone is noncalcareous, but in places it contains enough lime to effervesce with acid. In the western part of the area covered by this soil are outcrops of thin-bedded reddish-brown sandstone, and the soil here is more sandy than in the eastern part.

Large areas of this soil extend south and east from Ashokan Reservoir to Esopus Valley and northeast to the county line. Practically none of the land is under cultivation, and very little is used as grassland. The forest growth includes considerable black oak and, where the soil is very shallow, scrub bear oak.

Albia gravelly loam.—Albia gravelly loam consists of light-brown or slightly yellowish brown finely granular gravelly loam to a depth of about 8 inches. This is underlain by a more silty gravelly loam having a small-clod structure. At a depth of about 18 inches, the soil material is dull-brown very compact gravelly loam strongly mottled with yellowish brown, rusty brown, and light gray. This compact layer extends to a depth of about 30 inches, below which the lower part of the subsoil is mottled but more friable and also more gravelly. The gravel on the surface and throughout the soil consists principally of nearly white crystalline conglomerate from the Shawangunk formation, and, in places, large masses of the same material are scattered thickly over the surface. The surface soil is moderately acid, and the subsoil is somewhat less acid.

Areas of Albia gravelly loam extend along the eastern slope of the Shawangunk Mountains from a few miles south of Rosendale to Ulsterville at the southern extremity of the county.

Small areas are included, in which the soil differs from typical Albia gravelly loam in having more gravel and stone on the surface and throughout the soil and more large stone masses on the surface. Such areas, as a rule, occur higher on the slopes than does the typical soil, and, in places, the surface is thickly covered by masses of stone that have fallen from the face of the steep escarpment to the west. Areas of this soil afford some pasturage. Neglected areas support practically pure stands of poverty oatgrass (*Danthonia spicata*). In a few included areas, the surface soil is slightly sandy.

Albia gravelly loam is not highly productive, but about one-half of it is used for intertilled crops, for small grains, and for grass. Corn returns from 10 to 20 bushels an acre; wheat, 8 to 12 bushels; oats, 15 to 25 bushels; and potatoes, 25 to 50 bushels.

Wurtsboro gravelly sandy loam.—This is a Podzol soil developed from Shawangunk quartzite, shales, and sandstone materials depos-

ited as deep glacial till on the crest and slopes of Shawangunk Mountains. The soil is developed from about 80 percent of quartzite conglomerate and 20 percent of coarse Catskill sandstone and Hudson shales.

Under a thin layer of leaf litter and a fine crumbly black mull is a light-gray to nearly white layer of sandy loam about 3 inches thick. This is underlain by yellow or light-brown gravelly sandy loam slightly stained with rusty brown in the lower part. This, in turn, is underlain by a compact platy silt loam highly mottled with yellow, light gray, and rusty brown. Below a depth of about 30 inches the subsoil is more gravelly and stony but less compact. It is strongly acid in the surface soil and less so in the deep subsoil. Surface drainage is good, but underdrainage is restricted. The land formerly supported a forest growth of hardwoods, together with some white pine and pitch pine, but now it supports a mixed second growth, principally maple, birch, and beech. It includes many shallow and stony areas, stone outcrops, and ledges. A few areas are, or have been, under cultivation.

Included with this soil in mapping are areas having, under forest conditions, a dark-gray 1- to 2-inch covering of mulch and a yellowish-brown gravelly loam surface soil, in which the gravel is largely sharp crystalline material. At a depth of about 7 inches, this material grades into lighter yellowish-brown slightly heavier gravelly loam. At an average depth of about 15 inches this, in turn, grades into gravelly loam, strongly mottled with light gray, yellowish brown, and rusty brown, extending to a depth ranging from 20 to 24 inches. Below this is dull-brown very compact gravelly loam, which grades into a more friable lower subsoil layer. This soil is variable in depth and includes many areas of shallow soil and of rock outcrop. The depth to the compact layer and also the amount of compaction varies from place to place. The soil is acid in the surface soil and slightly acid in the subsoil. The forest growth includes oaks, maple, ash, hickory, and associated varieties of trees. The principal areas of this included soil are in the vicinity of Minnewaska and Mohonk Lake and north and northeast of Walker Valley. Parts of it have been under cultivation but are now almost entirely abandoned for farming.

Culvers fine sandy loam.—The 2- or 3-inch surface layer of Culvers fine sandy loam is dark-brown finely granular fine sandy loam containing considerable organic matter. It grades into reddish-brown slightly silty gravelly fine sandy loam. At a depth of about 14 inches this gives way to distinctly reddish brown heavier gravelly fine sandy loam, with a slight purple tint, which contains gray mottling in the lower part. At a depth ranging from 24 to 30 inches is reddish-brown or purplish-red compact gravelly fine sandy loam, which is more friable in the lower part. This soil is variable in depth, in the degree of compaction, and in the content of stone. Some areas are included from which the stone have been removed and built into stone fences, but originally the soil was stony. Many areas of stony loam also are included. This soil is acid, the reaction ranging from strongly acid near the surface to moderately acid in the lower part of the subsoil.

This soil is developed principally in the southwestern part of the county, especially west of Yagerville, southwest of Lackawack, and around Greenfield. It grades into a redder, slightly heavier, and more silty soil toward the west, where dull-red shale lies at a slight depth in a few places. Surface drainage is good and internal drainage is slow in the typical soil, but a small proportion of the total area is well drained.

The soil is used largely for grassland but also for the production of corn, small grains, and other crops. Yields of corn range from 15 to 25 bushels an acre; wheat, 8 to 15 bushels; oats, 15 to 25 bushels; and potatoes, 50 to 65 bushels.

Culvers stony fine sandy loam.—Culvers stony fine sandy loam differs from Culvers fine sandy loam in the larger quantity of stones on the surface, the greater extent of shallow areas, and the more numerous rock outcrops and ledges. This land is used to a limited extent for pasture and grassland but principally for forestry. Large areas extend northeast from Lackawack and west and southwest from Ellenville. Internal drainage is slow in the typical soil, but a considerable area of well-drained Catskill stony fine sandy loam is included in mapping.

Culvers gravelly loam.—Culvers gravelly loam, to a depth of about 8 inches, is dark slightly reddish brown gravelly loam, which is rather silty in texture and finely granular. This is underlain by pale reddish-brown compact gravelly loam containing sharp sandstone gravel. The material has a small-clod structure, and the clods crumble readily. At a depth of 18 or 20 inches the subsoil is compact, very gravelly, and mottled with gray. The compact layer extends to a depth of 24 to 30 inches where it gives way to more friable, very gravelly material. The reaction is strongly acid in the surface soil, and the lower part of the subsoil is moderately acid. Like Culvers fine sandy loam, this soil is gravelly and, in places, stony. Its partial freedom from stones likewise is due to removal of the original stones. Much of the soil is a stony loam but has been included with the gravelly loam because it is less stony than the greater part of Culvers stony loam. Internal drainage is slow, except in a number of included areas of well-drained Catskill gravelly loam.

The most extensive areas are developed on the rather steep lower mountain slopes in the vicinity of Tabasco, Krumville, and Samsonville.

The soil is used for pasture and grassland and, to some extent, for the production of corn, small grains, buckwheat, and potatoes. Yields are low, and extensive areas formerly farmed are now abandoned.

Culvers stony loam.—Culvers stony loam closely resembles Culvers gravelly loam. Shallow, stony, and gravelly areas, rock outcrops, and rock ledges are common. The soil extends as a more or less broken belt from a point near Ellenville northeast through West Saugerties to the county line. Practically all of the land is in forest including maple, birch, ash, beech, aspen, and other species of trees. This soil, as mapped, includes a number of areas of Catskill stony loam which were not separately mapped because of their low agricultural value.

Lackawanna silt loam.—Under forest conditions, Lackawanna silt loam consists of dark-brown or almost black granular silt loam containing partly decayed organic matter in the upper part and underlain, below a depth of 2 or 3 inches, by dull-red granular silt

loam, in which are thin fragments of soft slate. Below a depth of 12 inches is dark Indian-red slaty silt loam, which extends to a depth ranging from 24 to 30 inches where it grades into partly disintegrated slate or shale of the same color. In some places there is a compact layer at a depth of about 20 inches, but elsewhere there seems to be no marked compaction of the subsoil. The reaction ranges from strongly acid in the surface soil to moderately acid in the lower part of the subsoil. Stony areas are scattered throughout bodies of Lackawanna silt loam, in which outcrops, principally of red sandstone, and ledges are so numerous that the soil is of but little value except for pasture, grassland, and forest.

Lackawanna silt loam is considered the best soil in the western part of the county for the production of potatoes and other farm crops. Its extent, however, is not large. In Hardenburg Town near the county line it is used for growing cauliflower and brussels sprouts, and heavy applications of lime and fertilizer are necessary. Corn yields from 25 to 35 bushels an acre; wheat, 12 to 15 bushels; oats, 20 to 40 bushels; potatoes, 60 to 100 or more bushels; and timothy and clover, 1 to 1½ tons. The forest growth consists of hard maple, black birch, wild cherry, and other associated species.

Greater care is taken in preparing the land for cauliflower than for any other crop grown. Sod is preferred, and, if possible, it is plowed in the fall. In the spring it is thoroughly disked and harrowed. Lime, at the rate of about 2 tons of ground limestone an acre, is applied and is worked into the soil well, after which manure, at the rate of 10 to 12 tons an acre, is applied. In addition, a heavy application of commercial fertilizer, at the rate of 1,000 to 2,500 pounds an acre, is made. Some growers use a 5-8-7[†] mixture. The plants, which are started in coldframes, are, if possible, set out between May 25 and June 1 and are carefully cultivated until the crop matures in late July or early August. The matured crop is marketed in crates in New York City, and most of it is transported by truck.

Walton gravelly silt loam.—Walton gravelly silt loam occupies valley slopes and low drumlinlike formations. Where typically developed, the 6- or 7-inch surface soil consists of dark-brown gravelly finely granular light-textured silt loam. Some of the gravel-stones are rounded and water-worn. This layer is underlain by brown or slightly reddish brown friable gravelly loam, which extends to a depth of about 24 inches, and below this is a slightly more compact and, in places, very gravelly layer. This soil is acid, the reaction being about the same as that of Lackawanna silt loam. In the Catskill Mountains it occurs as narrow strips along the lower slopes bordering the valleys. Here the slope is steep, and the surface, in many places, is too rough and broken for profitable cultivation. Several bodies along the north side of Ashokan Reservoir are included with Walton gravelly silt loam, in which the soil has developed largely from glacial till and from old outwash material, and therefore they are more nearly level. In such areas the subsoil is more compact than in the typical soil and contains some mottlings of gray and rusty brown.

[†] Percentages, respectively, of nitrogen, phosphoric acid, and potash.

Although this is one of the best soils in the adjacent county (Delaware), it is of only medium agricultural value in Ulster County, and very little of it is cultivated. The principal areas are along the slopes bordering Beaver Kill and Saw Kill near Lake Hill, from Kerhonkson and Granite northeastward almost to Rosendale, and in a few other places.

SOILS OF THE TERRACES AND OUTWASH FANS

Soils of the terraces and outwash fans have developed from material that has been carried by water or by water and ice, more or less assorted, and deposited in thin beds or layers of various kinds. Much of the gravel has been rounded or water-worn. Soils of this group are of two general kinds: (1) Soils developed from sandy and gravelly materials, and (2) soils developed from silt and clay materials.

The soils developed from sandy and gravelly materials are the more extensive and variable. They are well drained and, where not too coarse and droughty, are fairly well suited to general farming. In favorable situations they are very well adapted to fruit growing. Members of the Hoosic, Agawam, Merrimac, Otisville, Chenango, and Tunkhannock series comprise this subgroup.

Soils of the Hoosic series are brown or dark brown and are gravelly in the surface soil. They are lighter brown in the subsoil and are underlain by beds of small more or less rounded gravel, in which much of the material is of shale or slate origin.

Soils of the Agawam series differ from those of the Hoosic series in being more sandy and in containing less slate and shale gravel in the subsoil.

The Merrimac soils consist of coarse gravelly sandy loam underlain by a gravel mixture of granite, quartzite, and other rocks.

The Otisville and Hoosic soils are similar in that they are shallow and gravelly and are underlain by beds of sand and water-worn gravel. Instead of occurring on terraces as do the Hoosic soils, however, the Otisville soils have developed on rounded dome-shaped hills or kames, along the edges of terraces, and in other places where the slope is steep and erosion is active. Their productivity is lower, on the whole, than that of the Hoosic soils.

Soils of the Chenango series are brown to slightly reddish brown, have developed on high terraces from sand and rounded water-worn gravel, and differ from the Hoosic soils principally in the character of the parent material, which contains much crystalline material and some red and gray sandstone.

Soils of the Tunkhannock series are reddish brown or deep red, are gravelly and sandy, and are underlain by beds of rounded water-worn sandstone gravel. They are well drained and productive.

The soils developed from stratified materials containing much silt and clay are well suited to general farming, market gardening, and pasture. In some localities they are fairly well adapted to fruit growing. Characteristic features are the light-brown or reddish-brown color of their surface soils, their medium to heavy texture, and the alkaline to highly calcareous character of their subsoils.

They are included in two series—the Hudson soils, which have brown or yellowish-brown surface soils and dark bluish-gray sub-

soils or substrata, and the Schoharie soils which have light reddish-brown surface soils, and dark dull-red subsoils. A more or less broken belt of the Hudson soils extends along the valley of Wallkill River, principally along the western side, from the southern county line northward almost to New Paltz, and from a point near Kingston along Hudson River beyond the northern county line. Small areas occur in other places. The most extensive and important soil of this subgroup is Hudson silt loam. The Schoharie soils are slightly less calcareous than the Hudson soils.

Hoosic gravelly loam.—Hoosic gravelly loam has an 8-inch surface soil of rich-brown finely granular gravelly loam. Below this is slightly heavier and more compact brown or reddish-brown gravelly loam extending to an average depth of about 20 inches, below which depth the gravelstones are more abundant and slightly larger. This material is underlain at a depth, in most places, ranging from 30 to 40 inches, by dark-brown or grayish-brown rather fine slate or shale gravel, which is slightly sticky and apparently coated with colloidal material. Below this are layers of sand and coarse gravel. The surface soil is very strongly acid and in places has a pH value as low as 4.5. The acidity decreases downward, and the reaction of the subsoil, at a depth of 30 inches, is about neutral. In a few areas the gravelstones on the surface and throughout the soil are larger and more abundant than in the typical soil, and they interfere to some extent with cultivation. Corn yields from 25 to 35 bushels an acre; wheat, 12 to 18 bushels; oats, 20 to 35 bushels; buckwheat, 15 to 17 bushels; clover, 1 to 1½ tons; alfalfa, 1½ to 2 tons; and potatoes, 60 to 100 bushels.

A belt of this soil extends from Ohioville to the southern county line, between the Wallkill River and Marlboro Mountain, and small areas occur in many other places in the eastern part of the county. Nearly all of the land is under cultivation. Apples are grown extensively, and some of the best orchards of the Hudson Valley are on this soil. The land is easy to cultivate, is well drained, and allows deep rooting. Considerable fertilization is required for best results. Other tree fruits, grapes, other small fruits, and general farm crops are grown on this soil. Its principal objectionable feature is its occurrence in many places in small areas, which are separated by narrow strips of imperfectly and poorly drained soils. It is also associated with areas of Otisville soils, which are more rolling and subject to greater erosion.

Agawam sandy loam.—To a depth of about 7 inches Agawam sandy loam consists of brown medium to coarse sandy loam containing, in places, considerable quantities of small slate and shale gravels. Below this is lighter brown slightly heavier sandy loam, which grades into coarse loamy sand or gravelly sand below a depth of 30 inches. The lower part of the subsoil and substratum consist of dark-brown fine gravel and sand. The content of gravel is variable. In Esopus Valley the soil contains little gravel, but in Wallkill and Rondout Valleys the soil is more gravelly and in places is a fine gravelly loam.

A large part of this soil lies at a lower elevation than most of the Hoosic gravelly loam areas. In places it extends along the flood plains of Wallkill River and Rondout and Esopus Creeks, as well-

defined high terraces separated from the stream flood plains by a steep slope of 20 feet or more. Such a terrace extends along the Esopus Valley from Kingston north to Lake Katrine, and a considerable part of the city of Kingston is situated on this terrace.

In the vicinity of High Falls and distributed throughout a belt extending to Wawarsing are bodies of sandy loam, which is slightly redder, contains less slate gravel, and lies at a much higher elevation than typical Agawam sandy loam, with which it is included on the map.

Agawam sandy loam is used to much less extent for orchards than is Hoosic gravelly loam. Nearly all of it is devoted to cultivated crops, chiefly corn, small grains, and a few truck crops, or to grass-land. Corn yields from 15 to 20 bushels an acre; wheat, 8 to 12 bushels; oats, 15 to 25 bushels; buckwheat, 15 to 17 bushels; clover, three-fourths to 1 ton; alfalfa, 1 to 1¼ tons; and potatoes, 50 to 75 bushels.

Agawam loamy fine sand.—The surface soil of Agawam loamy fine sand is dark slightly reddish brown and light textured to a depth of about 6 inches. It is underlain by a more pronounced reddish brown heavier fine sandy loam, which grades into loamy fine sand of the same color below a depth of 18 or 20 inches. At a depth of about 30 inches this material, in turn, grades into grayish-brown loamy fine sand. The reaction ranges from strongly acid near the surface to slightly acid at a depth of 30 inches.

This soil occupies broad nearly level terraces, such as the Rosendale Plains on which Tillson is situated, or the terrace on which the larger part of Saugerties is situated, extending from Glasco northward to Esopus Creek. Many small areas are distributed throughout the eastern part of the county.

Practically all of this soil is or has been cultivated. It is used to some extent for orchards, for grapes, and for truck and other crops. Rather heavy fertilization is required, owing to its light sandy texture and naturally low productivity. Its situation high above the adjacent valleys and its excellent drainage afford favorable conditions for orchards. Corn yields 15 to 25 bushels an acre; wheat, 10 to 15 bushels; oats, 15 to 20 bushels; buckwheat, 10 to 12 bushels; potatoes, 60 to 75 bushels; and clover, 1 to 1½ tons.

Agawam loamy fine sand, rolling phase.—The rolling phase differs from typical Agawam loamy fine sand in having a looser, more open structure; less development of a soil profile, due to less weathering; less uniformity of color and texture; and more undulating to hilly or dunelike relief. In places, as along the northern edge of Rosendale Plains and between Kingston and Lake Katrine, it covers the hilly and broken areas along edges of terraces and seems to be an accumulation of sand blown from these more level areas. Also included are some rough and stony areas, in which the stones are partly exposed.

Parts of this rolling land are under cultivation, chiefly to corn, beans, and truck crops, but it is of low agricultural value and the larger part is in forest.

Merrimac gravelly sandy loam.—Merrimac gravelly sandy loam, to a depth of about 6 inches, consists of brown light-textured medium to coarse gravelly sandy loam, which grades into lighter brown slightly

heavier coarse sandy loam that, below a depth of 12 or 15 inches, contains more coarse sharp sand and gravel. At a depth ranging from 3 to 5 feet are beds of dark-brown water-worn gravel consisting of a mixture of granite, quartz, slate, and other rocks. The reaction ranges from strongly acid near the surface to slightly acid at a depth of 3 feet.

A few small areas of this soil lie east and south of Ulsterville in the southern part of the county. The land is used in the same way as Hoosic gravelly loam, but is somewhat less productive than that soil.

Otisville gravelly loam.—Otisville gravelly loam is grayish-brown finely granular light gravelly loam to a depth of 4 or 5 inches, where it grades into yellowish-brown gravelly loam. A large part of the gravel consists of small smooth slate fragments. Below a depth of about 16 inches the subsoil becomes lighter textured and more gravelly than the overlying material. The gravel fragments below a depth of 30 inches are larger than those above and occupy almost the entire soil mass. Below an average depth of about 4 feet are beds of dark-brown fine sharper slate gravel and sand, which are, in many places, tilted at a sharp angle. The reaction ranges from strongly acid at the surface to slightly acid or neutral at a depth of 3 feet. Gravel coated with lime is present in a few gravel pits, at a depth ranging from 6 to 8 feet.

Wide variations exist throughout the areas mapped as Otisville gravelly loam.

Within the belt of Hoosic gravelly loam extending along the east side of the Wallkill River from Ohioville south and southwest to the county line, areas of the Otisville soil are steeper and more rolling or more hilly than is typical. Here, the surface soil is also shallow and more gravelly, subject to greater erosion, and slightly more subject to injury from drought than elsewhere. This land is used extensively for apple orchards with nearly as good results as those obtained on the best Hoosic soils.

Masses of gravelly and sandy material, occurring as uneven and broken terraces, kames, small drumlins, and old outwash fans north and west of Ellenville, in the vicinity of Mombaccus, and in numerous other places in the central and western parts of the county, are included on the soil map with Otisville gravelly loam. In these places the gravel is of mixed origin, some of the deposits are shallow, and very little of the land is cultivated. Crop yields are much lower than in places where this soil is associated with the Hoosic soils.

On typical Otisville gravelly loam, corn yields from 5 to 15 bushels an acre; wheat, 5 to 10 bushels; oats, 10 to 15 bushels; buckwheat, 10 to 12 bushels; potatoes, 40 to 100 bushels; and clover, 1 to 1½ tons.

Otisville sandy loam.—Otisville sandy loam is dark grayish-brown sandy loam or fine sandy loam to a depth of about 4 inches, where it grades into lighter brown sandy loam, which continues to a depth ranging from 15 to 20 inches. Below this is light-brown light-textured gravelly sandy loam, in which the gravel is of mixed but largely sandstone origin. The material below an average depth of about 30 inches is very gravelly sandy loam. The depth to beds of gravel, as observed in road cuts, is variable. The gravel-free sandy loam or loamy sand, in places, is several feet deep. The soil is moderately acid near the surface and less acid at a depth of 30 inches.

This soil occurs along the outer valley of Rondout Creek in the vicinity of Ellenville, in areas having a very uneven small-hill relief. The land is of little value for cultivated crops and commonly is used for pasture.

Chenango gravelly loam.—The 7-inch surface soil of Chenango gravelly loam is brown or pale reddish-brown gravelly loam. It grades into slightly lighter reddish-brown heavier gravelly loam, which when dry is firm and breaks into irregular clods that can be crumbled readily. Below an average depth of about 36 inches the gravel fragments are larger and more abundant than in the overlying layers. At various depths the soil is underlain by stratified sand and rounded water-worn gravel, the layers of which, in places, are tilted and cross-bedded. The gravel consists largely of crystalline rocks mixed with some dull-red and olive-gray sandstone. The sand ranges from medium to coarse and sharp. Some areas consisting of heavy deposits of sand and other areas in which the soil has been deposited over large rock masses, some of which are now exposed, are included with this soil in mapping.

This soil occurs on high terraces, principally along the slope bordering the valley of Rochester Creek and in Rondout Creek Valley in the vicinities of Ellenville and Wawarsing. Here, it is associated with a poor grade of Otisville gravelly loam, which occupies the more eroded parts of the terrace.

The land is used to some extent for cultivated crops, and parts were planted to orchards by the early settlers. On the whole, however, it is subject to serious erosion and is of low agricultural value.

Tunkhannock gravelly loam.—The 6-inch surface soil of Tunkhannock gravelly loam consists of dark-brown or dark reddish-brown finely granular gravelly loam of light texture. It is underlain by a more pronounced reddish-brown heavier textured material with a small-clod structure. At a depth ranging from 18 to 24 inches, this material becomes more sandy and gravelly, and the lower part of the subsoil is very gravelly. Areas of this soil occur along Esopus Creek in the north-central part of the county.

This soil is well drained, productive, and suited to most of the crops commonly grown. The larger part of it, however, is outside the fruit-growing belt. Yields of corn range from 30 to 45 bushels an acre; wheat, 15 to 18 bushels; oats, 20 to 45 bushels; buckwheat, 15 to 18 bushels; clover, 1 to 1½ tons; and potatoes, 60 to 100 bushels.

Tunkhannock gravelly loam, rolling phase.—Tunkhannock gravelly loam, rolling phase, consists of dark slightly reddish brown light gravelly loam to a depth of about 7 inches. This material grades into darker reddish-brown light gravelly loam or sandy loam, and, below a depth of 18 or 20 inches, the material is dull Indian-red very gravelly sandy loam. The gravel fragments are larger, ranging from ½ to 3 inches in diameter, and are more abundant below a depth of 30 inches.

Very little of this land is under cultivation, but many old orchards, remnants of which may be found far back in the Catskill Mountains, were planted on this soil, together with slightly redder soils of the Tunkhannock series or soils of the Otisville series.

Tunkhannock gravelly loam, alluvial-fan phase.—The alluvial-fan phase of Tunkhannock gravelly loam is reddish brown or dull

red, light textured, and sandy and gravelly. Rounded stream gravel underlies the soil at a depth of 18 inches or less. In numerous areas the soil is very shallow and gravelly. Its agricultural value is low. It occurs along the lower courses of small streams, where they enter the larger valleys.

The parent material of this alluvial soil is of more recent origin than that of the typical Tunkhannock soils on the well-developed terraces. The soil is intermediate in development between the other Tunkhannock soils and the Barbour soils.

Hudson silt loam.—To a depth of 8 inches, Hudson silt loam, where typically developed, consists of light yellowish-brown finely granular silt loam of rather heavy texture. Below this is slightly paler yellowish-brown material with a small-clod structure, the clods crumbling easily. At a depth ranging from 16 to 20 inches, the texture is heavier and the sharp clods larger and harder than in the material above. At a depth of about 30 inches this material gives way to brown silty clay occurring in thin horizontal layers, which may be noted in many places in roadside cuts or gully banks, such as those along the highway south of Ganahgote. The substratum, below a depth ranging from 4 to 5 feet, consists of bluish-gray thinly stratified clay. The reaction ranges from moderately acid near the surface to neutral at a depth of 24 or more inches. The lower part of the subsoil and the substratum are well supplied with lime.

There are some gravelly areas, in which the deposit of water-laid soil material is so thin that it is mixed with some gravel from the underlying till or with gravel washed from the slopes above it. Such areas are indicated by gravel symbols at Libertyville, west of Katsbann, and elsewhere.

Practically all of this soil is devoted to the production of corn, small grains, clover, alfalfa, and other crops, or is in hay land or pasture. It is a strong productive soil. Its highly alkaline lower subsoil layer renders it well suited to the production of clover, sweet-clover, and alfalfa, but a light application of lime may be necessary in order to get these crops well started. The land is used to only a small extent for orchards or for growing grapes, to which purposes it is not so well adapted as the best Hoosic or Cossayuna soils but is better suited than the heavier types of the Hudson series. Hudson silt loam yields from 30 to 45 bushels of corn an acre, 15 to 20 bushels of wheat, 20 to 45 bushels of oats, 17 to 20 bushels of buckwheat, $1\frac{1}{2}$ to $1\frac{3}{4}$ tons of clover, 2 to $2\frac{1}{4}$ tons of alfalfa, and 50 to 100 bushels of potatoes.

Hudson silt loam, imperfectly drained phase.—The imperfectly drained phase of Hudson silt loam occurs in many nearly flat or broad slightly depressed areas. This soil differs from the typical soil in having a slightly darker surface soil and, between depths of about 8 and 20 inches, a light-brown or gray layer mottled with yellowish brown or rusty brown. Soil of this phase has a lower value than has the typical soil for most farm crops, but it is good land for pasture grasses.

Hudson silt loam, rolling phase.—Areas of Hudson silt loam west of Asbury, west of Saugerties, and elsewhere, which have a rolling or small-hill relief, due largely to erosion, are mapped as a rolling phase.

These areas are less desirable for farming than the more nearly level areas.

Hudson silty clay loam.—To a depth of 7 or 8 inches Hudson silty clay loam consists of brown, light-brown, or slightly yellowish brown very granular silty clay loam, the granules being about the size of wheat. This material grades into lighter brown silty clay loam which has a nut or small-clod structure, the small sharp clods being one-fourth to one-half inch in diameter. Below a depth of 15 inches this material, in turn, grades into lighter, more grayish brown clay, which breaks into larger hard clods and rests, at a depth of 24 inches, on darker brown slightly weathered thinly stratified clay. In some places these layers have tints of olive brown and, in others, tints of pale pink or red. The substratum, below a depth of 40 inches, is dull dark-gray stratified clay in most places.

The reaction of the surface soil is moderately acid, but, at a depth of 24 inches, it is slightly acid or neutral. The subsoil is alkaline.

Nearly all of this soil is or has been cultivated. About the same crops are grown as on Hudson silt loam. It is more difficult to cultivate and less productive than that soil, however, and parts are now abandoned for agricultural purposes. When dry, this soil checks and cracks severely in places, and such areas are best suited to grass and small grains.

Hudson silty clay loam, broken phase.—A broken phase of Hudson silty clay loam extends along the steep slopes bordering Hudson River from East Kingston northward to the county line. The naturally steep relief of this land has been increased by numerous deep excavations made in removing the clay for brickmaking, so that it is of very little value for agriculture or for other purposes except the mining of clay.

Hudson very fine sandy loam.—Hudson very fine sandy loam consists of brown or dark-brown light-textured very fine sandy loam to a depth of about 8 inches. Below this is light-brown or yellowish-brown heavier textured fine sandy loam or very fine sandy loam, which is underlain at a depth ranging from 24 to 30 inches, by thinly stratified clay. In places, the clay subsoil has the dark-brown or dark-gray color characteristic of the corresponding layer in other Hudson soils, but in other places it is pale red and resembles the subsoil of the Schoharie soils.

Although this soil is productive, it is not an important soil, on account of its small extent. A few small hilly areas are south of Kingston.

Schoharie silty clay loam.—The 6-inch surface soil of Schoharie silty clay loam is dull-brown or slightly reddish brown heavy silt loam or silty clay loam. It is underlain by dull-red silty clay, which breaks into small irregular hard clods. In level areas the upper part of this layer has some gray and rusty-brown mottlings. Below a depth of about 16 inches, the color is a darker Indian red and the sharp clods are slightly harder and larger than in the overlying layer. Below an average depth of about 24 inches, the material is dull-red thinly stratified clay. The reaction ranges from moderately acid near the surface to neutral in the upper part of the subsoil, and the clay below a depth of 2 feet is slightly alkaline.

Gravelly areas associated with this soil have a reddish-brown or dull-red heavy silty clay loam surface soil mixed with gravel from

the adjacent soils. In places such areas represent small remnants of old high terraces with a thin layer of sand and rounded gravel on the surface. In other places a shallow deposit is underlain by bedrock. The soil in most of these areas, however, consists of a thin deposit of red clay over gravelly slopes, the gravel of which is mixed with the clay or the red clay is modified by sharp gravel originating from the slopes above. An area of this kind extends along the south side of Rondout Creek southwest of High Falls. The gravelly areas are used in about the same way as the rest of Schoharie silty clay loam, but their value for crops is, on the whole, somewhat lower.

The largest areas of Schoharie silty clay loam occur as low well-rounded hills along the north side of Rondout Valley, extending from Wawarsing northeastward to High Falls. Small isolated areas are along the outer edge of this and other stream valleys. Near High Falls, the soil, in places, is shallow over bedrock.

The larger part of this land has been under cultivation, but, because it is heavy and difficult to cultivate most of it at present is used for pasture. Orchards have been planted in a few places, but the soil is poorly suited to this purpose, as the trees make a slow growth, and their roots are more subject to disease than in the lighter textured better drained soils. On account of the abundance of lime in the subsoil, the land should be utilized to greater extent for growing clover and sweetclover. Alfalfa might do well in some areas. Corn yields from 20 to 30 bushels an acre; wheat, 15 to 18 bushels; oats, 20 to 30 bushels; buckwheat, 15 to 18 bushels; clover, 1 to 1¼ tons; alfalfa, 1¼ to 2 tons; and potatoes, 30 to 75 bushels.

SOILS OF THE FLOOD PLAINS AND OF LOW-LYING IMPERFECTLY AND POORLY DRAINED AREAS

Soils of the flood plains and low-lying areas are more or less poorly drained and subject to overflow and deposition from adjacent areas.

The most important soils of the group are on the larger stream flood plains. These are comparatively well drained and range in color from rich dark brown in the southern part of the county to dark reddish brown or dull red in the northern part, depending on the source of the parent material. They are highly productive and are used for general farming and market gardening. Soils of the Tioga series are dark grayish brown and are best developed in Wallkill Valley. The color is more red and the texture, as a whole, is slightly lighter and more sandy in the Barbour soils than in the Tioga soils. The most representative areas of Barbour soils are in the valleys of Esopus Creek and of smaller streams in the northern part of the county. In Rondout Valley, the soils are intermediate in color between those of the Esopus and Wallkill Valleys but have been classed with the redder Barbour soils.

Soils of the low-lying poorly drained areas are characterized by a dark-gray or dark-brown surface soil and by a light-gray subsoil, strongly mottled with rusty brown and yellow. They are used mainly for pasture and forest.

The Middlebury soil differs from the Tioga and Barbour soils in having a less well drained subsoil, in which a layer of light gray mottled with yellow and rusty brown has developed.

The Holly soils, as mapped in this county, are dark colored, poorly drained, and strongly mottled with light gray and rusty brown in the subsoils. They are formed largely from material of alluvial origin in the flood plains of small streams.

Occurring in relatively the same low-lying and poorly drained positions occupied by the Holly soils but associated with the Cossayuna, Dutchess, and Albia soils, are soils of the Mansfield series. The material from which they have developed is of slightly different origin from that of the parent material of the Holly soils.

The Livingston soils resemble the Mansfield soils, with which they are closely associated, but differ from those soils in that they are underlain by bluish-gray and brown calcareous clay.

Soils of the Boynton series have developed from nearly the same material as have the Cossayuna soils but under less well drained conditions. They occupy almost level and low-lying areas. The surface soil is dark grayish brown, and the subsoil is moderately to strongly mottled with light gray, yellowish brown, and rusty brown. The subsoil ranges from neutral to slightly alkaline.

The Norwich soils represent the poorly and imperfectly drained areas within larger areas of Culvers and Lackawanna soils. They occupy nearly flat areas around ponds and stream heads and areas on steeper slopes. The Norwich soils are brown or dark grayish brown soils with strongly mottled gray and rusty-brown subsoils.

The Orono soils are closely associated with the Hudson soils and are formed from nearly the same parent material but have been influenced by poor drainage.

Soils of the Poygan series are associated with soils of the Schoharie series, from which they are distinguished by darker, less well drained surface soils and the presence of a gray and mottled layer in the upper part of the subsoils.

The Braceville soils consist of grayish-brown granular surface soils underlain by gray silt loam, strongly mottled with rusty brown, which grades, below a depth of 24 inches, into light-gray gravelly sand.

The surface soils of the Basher and Braceville soils are similar, but the surface soils of the former are underlain by pinkish-red and gray strongly mottled silty clay, which grades into fine sandy clay below a depth of 24 inches.

Tioga silt loam.—Tioga silt loam consists of rich, dark, slightly reddish brown granular silt loam to a depth of about 9 inches, where it grades into lighter brown heavier silt loam with a cloddy structure. Below a depth of about 18 inches the rather hard clods are larger, but the color remains the same. The surface soil is moderately acid, and the subsoil is slightly acid. Where the soil is well drained and typically developed, it varies but little either in color or texture to a depth of 3 feet. In many places, however, under-drainage is not so good, and mottlings of gray and rusty brown are present below a depth of about 18 inches. These imperfectly drained areas are intermediate between typical Tioga soils and Middlebury silt loam.

Tioga silt loam is subject to occasional overflow and deposition. The principal areas are in the Wallkill and Shawangunk Valleys where it is practically all under cultivation. The crops grown are corn, small grains, clover, and some alfalfa and truck crops, of which the yields are fair to good. Corn yields from 40 to 50 bush-

els an acre; wheat, 15 to 20 bushels; oats, 20 to 50 bushels; buckwheat, 15 to 20 bushels; clover, $1\frac{1}{2}$ to 2 tons; alfalfa, $1\frac{1}{2}$ to 2 tons; and potatoes, 60 to 100 bushels.

Tioga fine sandy loam.—The surface soil of Tioga fine sandy loam is dark-brown granular fine sandy loam or very fine sandy loam, well filled with grass roots to a depth of about 10 inches, where it grades into light-brown or yellowish-brown very fine sandy loam. At a depth of 18 or 20 inches, this gives way to yellowish-brown loamy fine sand and small gravel. This soil has about the same reaction as Tioga silt loam.

Included with Tioga fine sandy loam are areas in which the surface soil is brown or dark-brown moderately heavy gravelly sandy loam. The gravel fragments are small, water-worn, and not very abundant. Below a depth of about 6 to 9 inches is yellowish-brown gravelly sandy loam, which rests on sand and gravel at a depth ranging from 24 to 30 inches. Several small areas of this kind occur in the southern part of the county near Walker Valley. In the vicinity of Springtown is an area of gravelly soil occupying a low terrace along the west side of the Wallkill Valley, which closely resembles the Hoosic soils. Elsewhere in smaller valleys this included gravelly soil is shallow, variable, and of rather low agricultural value.

Tioga fine sandy loam, as typically developed, occurs in long narrow strips and small areas near the stream channel or along the edges of low terraces. All the land is cultivated. The same crops are grown as on Tioga silt loam, and yields are about the same or slightly lower than on that soil.

Barbour silt loam.—Barbour silt loam is dark reddish-brown granular silt loam to a depth of about 9 inches, where it grades into slightly lighter reddish-brown silt loam, which breaks into small easily crumbled clods. Below a depth of 18 or 20 inches, the texture is slightly more silty and heavy, and the clods are somewhat harder than in the material above. This material, in turn, grades into light silt loam or very fine sandy loam below a depth of 30 inches. The reaction is acid in the upper part of the surface soil and somewhat less acid in the lower part of the subsoil.

Along the edges of low terraces, as low ridges, and in some level places are areas in which the surface soil is very fine sandy loam instead of silt loam. This soil differs so little from Barbour silt loam that it is included with it on the map.

This was the first soil cultivated by the early settlers, and it had been cultivated previously by the Indians. Large tracts in the vicinity of Kingston are still highly productive and are used for a wide variety of garden and truck crops as well as for general-farm crops, such as corn, small grains, and grass. Since the waters of Esopus Creek are now impounded in Ashokan Reservoir, the flood plain is no longer subject to overflow. Nevertheless, during the course of this survey, it was observed that many areas were not cultivated, or, if used for corn and small grains, were poorly farmed. In the valley of Rondout Creek where this soil is developed in large bodies, it has about the same crop value and uses as near Kingston. A few areas are intensively cultivated and used for truck crops. Yields of corn range from 30 to 50 bushels an acre; wheat, 15 to 18 bushels; oats, 20 to 50 bushels; buckwheat, 15 to 20 bushels; clover, $1\frac{1}{2}$ to $1\frac{3}{4}$ tons; and alfalfa, $1\frac{1}{2}$ to 2 tons.

Barbour loamy sand.—Barbour loamy sand has a dark-brown or dull reddish-brown surface soil of rather fine texture, about 10 inches thick, underlain by slightly more reddish brown loamy sand, which extends to an average depth of 3 feet, where it grades into sand and gravel. This soil is rather variable. In some areas the loamy sand is fine and alternated with thin layers of sandy loam or fine sandy loam; in others it is coarse, loose, and contains rounded gravel.

On account of its light sandy texture and loose consistence, it has a rather low value for crops and is used principally for small grains and for corn. The larger areas are in Esopus Valley.

Barbour gravelly sandy loam.—The 4- or 5-inch surface soil of Barbour gravelly sandy loam consists of reddish-brown or dark reddish-brown sandy loam grading into slightly lighter red or reddish-brown gravelly sandy loam or loamy sand. This material rests, at an average depth of about 15 inches, on sand and rounded water-worn gravel. This soil includes rather wide variations, ranging from small bodies, in which the surface soil is sandy only slightly gravelly loam, 18 inches or more thick, to larger bodies, in which the surface soil is shallow and very gravelly. Much of the gravel is red sandstone.

This is the predominating soil in the narrow valleys of the streams that drain the Catskill Mountains. Where the gravel has a sufficient covering of sandy material, the soil can be used for gardens and other crops, but the areas of more shallow soil are of but little value except for the scant pasture they afford. Included in mapping are numerous small areas of riverwash, not sufficiently extensive to warrant separation.

Barbour loam.—Barbour loam differs from the other typical Barbour soils in its darker Indian-red color. It occurs in the valleys of Plattekill Creek and other small streams in the northeastern part of the county and extends farther north into Greene County.

It consists of dark reddish-brown finely granular light silt loam or loam of fine texture to a depth of about 9 inches. This grades into dark Indian-red friable silt loam, which changes to slightly lighter Indian red below a depth of 18 inches and grades into lighter textured silt loam below a depth of 30 inches. The texture of this soil is rather variable, ranging from moderately light sandy loam to silt loam; the deep-red color, however, is persistent.

The soil seems to have about the same agricultural value as Barbour silt loam, but it is used principally for corn, small grains, and grasses. Yields are about the same as or slightly lower than those obtained on Barbour silt loam.

Middlebury silt loam.—This soil differs from the Tioga and Barbour soils in having a subsoil that is not so well drained as the corresponding layer in those soils and in which a layer of light gray mottled with yellow and rusty brown has developed. In typical areas, the 8-inch surface soil is dark-brown or dark grayish-brown heavy granular silt loam. It is underlain by lighter yellowish-brown or grayish-brown silt loam, which is moderately mottled with light gray and breaks into small, rather hard clods. Below a depth of about 24 inches this material gives way to light-gray silty clay loam, strongly mottled with yellowish brown and rusty brown.

This soil is variable, depending on drainage conditions. In places, the dark surface soil is shallow, and the light-gray silt layer is

reached at a depth of 6 inches or less. In other places, where drainage is better, the dark-colored surface soil is much thicker. A few areas having a loamy or sandy surface soil are included with this soil on the map, together with a few low-lying areas in which the lower part of the subsoil is nearly black and filled with partly decayed organic matter.

Many small areas of Middlebury silt loam occupy parts of Esopus, Rondout, and Wallkill Valleys. Some of the land is cultivated, but most of it is used for pasture. Its value for cultivated crops is considerably lower than that of the better drained Tioga and Barbour soils.

The reaction, in some places, is moderately acid and, in others, is slightly acid, but the difference between the reaction of the surface soil and that of the lower part of the subsoil is slight.

Holly silt loam.—The surface soil of Holly silt loam consists of dark grayish-brown or nearly black coarsely granular silt loam, to a depth of about 7 inches, which grades into grayish-brown silt loam mottled with rusty brown. Below a depth of 15 inches, the color is lighter gray, the rusty-brown mottlings are more evident, and the texture is heavier than in the material above. The lower part of the subsoil is variable, in some places being sand and gravel, and in others, heavy silt or clay.

Narrow strips of this soil extend along the small stream channels in all the more nearly level parts of the county, and, in places, in the valleys of the larger streams. Very little of the land is under cultivation. Some is used for pasture or grassland, but the greater part supports a thick growth of alder, swamp willow, and other shrubs and plants, which grow under wet, poorly drained conditions. Loosestrife, or rebel weed, is abundant in many cleared areas.

Holly sandy loam.—Holly sandy loam occupies rather broad poorly drained areas in the larger valleys and is the principal soil in some of the smaller valleys. It consists of dark-gray or dark grayish-brown sandy loam to a depth of about 8 inches. This is underlain by light-gray sandy loam mottled with yellowish brown to a depth of about 15 inches, below which the texture is heavier, ranging from heavy sandy loam to sandy clay, and the yellow and brown mottlings are more pronounced. At a depth of 30 inches this material grades into bluish-gray sandy clay, which is not mottled or only slightly so.

Owing to its sandy texture and poor drainage, the agricultural value of this soil is low. Only a small part of it is cleared and cultivated. The rest is used for pasture or grassland or remains uncleared.

Mansfield silt loam.—Mansfield silt loam consists of dark-gray or nearly black heavy silt loam, which changes to slightly lighter gray below a depth of 5 inches. At a depth of 8 inches, this material grades into light-gray and yellowish-brown strongly mottled heavy silt loam extending to a depth of about 28 inches. The material in the lower part of the subsoil is gravelly and breaks into large hard clods when dry. Below this is light-gray slightly mottled very stony fine sandy clay.

Small areas are included with this soil in mapping, which are so stony that they are entirely unsuited for cultivation. Large stones cover the surface and are thickly distributed throughout the soil.

Some of the areas have been cleared and are used for pasture. The greater part of the land, however, is overgrown with shrubs and trees.

Mansfield silt loam occupies long narrow imperfectly and poorly drained strips or belts in the more nearly level parts of the county. In places, these belts include areas of Holly soils, which are too narrow and unimportant to warrant separation. The land is used to a limited extent for the production of small grains and for pasture. Loosestrife, or rebel weed, grows thickly in cleared areas. On the narrow strips, which extend into or through orchards, the trees grow slowly and are unproductive. Much of the land is uncleared.

Mansfield gravelly loam.—Mansfield gravelly loam differs from Mansfield silt loam in position and in the kind of material from which it has developed. It occupies imperfectly and poorly drained areas on the lower slopes of the Shawangunk Mountains and has developed largely from crystalline material, in association with the Albia soils.

It consists of dark-gray gravelly loam to a depth of about 7 inches. This is underlain by light-gray gravelly loam mottled with yellow and rusty brown. The material is very gravelly and compact below a depth of 20 inches and rests, at a slight depth, on stony loam. In some small areas, a large quantity of stone is on the surface and throughout the soil.

Aside from the small amount of pasture it affords, Mansfield gravelly loam is of slight value except for forestry.

Livingston silty clay loam.—Livingston silty clay loam is closely associated, in places, with Mansfield silt loam, which it resembles in the surface soil; its lower subsoil layer and substratum, however, are dark bluish-gray slightly calcareous clay. In other places it occurs within low-lying poorly drained areas of Hoosic and Cossayuna soils and, in many places, is associated with areas of muck.

The 6-inch surface layer is dark grayish-brown or nearly black coarsely granular heavy silt loam. It grades into dark-gray silty clay loam, mottled with light gray and rusty brown, which has a small hard-clod structure. At a depth of 12 inches is light-gray and rusty-brown clay, which gives way, at a depth of about 24 inches, to bluish-gray and brown calcareous clay. The surface soil is neutral in reaction, and, in places, below a depth of 30 inches, the material is alkaline.

This land is not cultivated, and most of it is too wet even for use as pasture. As on Mansfield silt loam and much of the Holly silt loam, a dense growth of loosestrife covers the areas from which the forest has been cleared.

Boynton silt loam.—Boynton silt loam is dark-gray or dark grayish-brown silt loam to a depth of about 7 inches. The upper part of the surface soil is granular, and the lower part has a small-clod structure. This is underlain, to a depth of 15 inches, by pale yellowish-brown rather heavy silt loam, which also has a small-clod structure. Below this is light-brown silt loam, mottled with light gray and rusty brown. Below a depth of 24 inches is brown gravelly or stony silty clay loam strongly mottled with light gray and rusty brown.

This soil is closely associated with the Cossayuna soils, but it occupies nearly flat, lower lying, less well drained areas. Most of it occurs in small bodies, many of which, on account of their limited extent, are included on the map with the Cossayuna soils. The principal areas are west of Milton, near Gardiner, east of Jenkinstown, and west of High Falls.

In its natural state, this soil is best suited to grass, or, if drained, it may be used for the production of oats, corn, cabbage, and other crops. There are some orchards on it, but it is doubtful whether this soil, even by draining, can be made to grow highly productive fruit trees or trees that will live to maximum maturity. Approximately 75 percent of this soil is cleared farm land. On drained soil, corn yields from 15 to 25 bushels an acre; oats, 20 to 30 bushels; wheat, 8 to 12 bushels; and buckwheat, 12 to 15 bushels.

Norwich loam.—The surface soil of Norwich loam, to a depth of about 8 inches, is dark-gray or dark-brown granular silt loam. This is underlain, to a depth of 20 inches, by lighter grayish-brown or light-gray silt loam strongly mottled with yellow and rusty brown in the lower part. This material gives way to reddish-brown or purplish-brown compact sandy clay, which, in places, is stony.

This soil is developed in fairly large areas in the central and southwestern parts of the county, mainly around ponds or along drainage-ways. In the lower positions it is closely associated with Holly silt loam, and in higher positions on slopes it is surrounded by the Culvers and Lackawanna soils.

The total area indicated by stone symbols is much larger than that of the nonstony loam. It is slightly lighter, that is, more loamy, in texture, and has approximately the same soil profile, but the land is so stony that, even if drained, it would be nonagricultural. All this stony soil is in forest, including hemlock, white birch, soft maple, hardhack, alder, and swamp dogwood. The most extensive stony areas are associated with the Culvers soils in the southwestern part of the county around Greenfield and Ulster Heights.

Norwich loam is utilized to some extent for growing grass and for pasture but to only a limited extent for cultivated crops. Its agricultural value is very low.

Orono silty clay loam.—Orono silty clay loam is closely associated with soils of the Hudson series and has developed from nearly the same parent material as those soils, but under imperfect and poor drainage conditions.

To a depth of about 10 inches, the Orono soil consists of very dark gray to black decidedly granular heavy silt, in which grass roots are plentiful. Below this is light-brown or light-gray silty clay loam, strongly mottled with yellowish brown and rusty brown, which continues to a depth ranging from 24 to 30 inches. This material rests on bluish-gray stratified calcareous clay.

This soil occurs as broad shallow valleylike areas in association with Hudson silt loam in Wallkill Valley and near Hudson River from East Kingston northward to the county line. In most places it is too wet and too poorly drained for cultivated crops, but much of the land has been cleared and furnishes excellent pasture.

Poygan silty clay loam.—Poygan silty clay loam has a dark-gray or nearly black granular surface layer, about 6 inches thick, underlain by a yellowish-brown and light-gray strongly mottled heavy-textured layer. The material in this layer grades into dull Indian-red clay, moderately mottled with gray and brown, and passes, below a depth of 24 inches, into dull Indian-red stratified clay like that in the lower part of the subsoil of the Schoharie soils. The Poygan soils are, in fact, like Schoharie soils, except that imperfect drainage has caused the development of a dark surface soil and of a gray and mottled layer in the upper part of the subsoil. A few areas, which have a thin surface cover of sandy soil, are included with the heavier soil in mapping, on account of their small extent.

Poygan silty clay loam occurs in small areas, generally in association with Schoharie silty clay loam, but it is of lower agricultural value than the Schoharie soil. Its principal use is for pasture.

Braceville silt loam.—Braceville silt loam consists of grayish-brown or dull-gray granular silt loam to a depth of about 7 inches. Below this is gray silt loam, which contains strong mottlings of rusty brown and has a small-clod structure. At a depth of about 16 inches this material grades into lighter gray more sandy silt loam, also mottled with rusty brown. Below a depth of 24 inches the material is light-gray gravelly sandy loam. The reaction ranges from slightly acid in the surface soil to slightly alkaline in the lower part of the subsoil. More typically, Braceville silt loam is acid throughout the soil mass, but in Ulster County it receives enough lime-charged water from adjacent soils to keep the subsoil alkaline.

This soil is developed in a broad high valley east of Kripplebush and is used for corn, small grains, and grass. Its productivity ranges from medium to low. Corn yields range from 15 to 25 bushels an acre; wheat, 8 to 12 bushels; oats, 12 to 20 bushels; buckwheat, 10 to 15 bushels; clover, three-fourths to 1½ tons; and potatoes, 40 to 60 bushels.

Basher silt loam.—The surface soil of Basher silt loam is dark-gray coarsely granular silt loam, about 8 inches thick, underlain by yellowish-brown, gray, and reddish-brown silt loam. This grades, below a depth of 16 or 18 inches, into pinkish-red and gray strongly mottled silty clay, which, below a depth of 24 inches, grades, in turn, into fine sandy clay.

In the valley of Esopus Creek, narrow belts of soil bordering small streams, which flow into and across the valley, are included with this soil in mapping. A small area is at Mount Marion, and others are northeast of Woodstock.

Basher silt loam occupies nearly level imperfectly drained areas. It is used for small grains, for grasses, and, in the lower lying areas, for pasture only. The productivity is low.

Muck.—Numerous small areas of muck, only a few of which have been drained and put into use, are in the southeastern part of the county. A large area borders Swarte Kill, east of Ohioville. Several fairly large areas are around Ulster Heights in the southwestern part. Typical areas consist of black fibrous muck, to a depth of about 12 inches, below which is dark-brown peaty muck extending to a depth of 3 feet or more. In places around the edges of the areas, the muck is shallow and is underlain by nearly white marl. Near the highway

in the State farm near Wallkill in the southern part of the county is an area of this kind. Market-garden crops, principally celery, lettuce, onions, and potatoes, are grown on the cultivated areas.

MISCELLANEOUS LAND TYPES

Riverwash.—Closely associated with Barbour gravelly sandy loam is riverwash, which consists almost entirely of rounded gravel, much of it red sandstone without a sandy covering or with but a very thin covering of sand. In places this material fills the channels of the streams flowing out of the mountains so that their course is diverted into new channels or can be kept in the old channel only by dredging. Riverwash has no agricultural value.

Made land.—The term "made land" is applied to soil material, which has been recently moved, as that in railroad fills, quarry dumps, and clay and gravel pits, and has not been sufficiently weathered to form a true soil. It has practically no agricultural value.

Rough stony land.—The term "rough stony land" is applied to sections, in which rock ledges, rock outcrops, and large loose stones are so abundant that the greater part of the land has no value for cultivated crops, but slight value for pasture, and low value for forestry.

In the eastern and southeastern parts of the county, including Marlboro Mountain and some adjacent areas, are bodies of rough stony land, in which massive thick-bedded calcareous sandstone is exposed at the surface or lies in large broken masses on the steep slopes. Through these bodies are small isolated areas, which combined are estimated as less than 10 percent of the total area, in which the soil would be classed as Cossayuna gravelly loam or as a shallow phase of that soil if the areas had been more extensive. Some of these small areas are used as grassland and for cultivated crops. The rest of the land has but little agricultural value even for forestry, but, on account of its favorable location near a highway and in sight of Hudson River, it offers favorable sites for summer homes and for recreational purposes.

Covering the higher parts of Shawangunk Mountains, extensive areas are mapped as rough stony land, in which the Shawangunk conglomerate has a very shallow soil covering and in which, in places, the nearly level smooth bedrock is almost bare. Where the depth allows, the soil has the development of a Podzol, the dark-brown or nearly black, granular, and strongly acid surface soil being underlain by a light-gray sandy leached zone. Included in mapping is an area near Sams Point, in which the soil is deeper than typical, owing to a deposit of glacial material, and is well podzolized. The rough stony land of the Shawangunk section supports only a sparse forest growth, largely of small jack pine, and huckleberries grow thickly in most places.

Rough mountainous land (Culvers soil material).—Rough mountainous land (Culvers soil material) includes areas of rough stony land, in a large part of which the soil covering is sufficiently deep to allow a fair-to-good forest growth and on parts of which good pasture grasses may be grown. The larger part of the Catskill Forest Preserve is of this kind. The soil has developed largely from materials which give rise to the Culvers soils.

LAND USES AND AGRICULTURAL METHODS

On account of the trend of agriculture toward specialized crops in this section, a brief consideration of soil adaptation for these crops seems advisable.

For their best development, apples require deep well-drained soils of medium texture. The roots of mature trees of most varieties on such soils reach to a depth of 8 feet or more. Good growth and fair yields may be obtained on shallower but otherwise favorable soils, but seasonal conditions, especially drought, influence production on these soils to a greater extent than on the deeper soils.

Hoosic gravelly loam, the best areas of Otisville gravelly loam, Cossayuna gravelly loam, and Dutchess gravelly loam are among the best soils for apple orchards. These soils lie near the Hudson River, where air drainage is good and where the danger of winter-killing or frost injury is least. Agawam sandy loam and Agawam loamy fine sand also are within this fruit belt and, although used to only a small extent for apple orchards, seem to offer good opportunity for such planting. The principal objectionable features of the Hoosic soils are their occurrence in small areas separated by narrow strips of poorly drained soils unsuited for growing trees; their light sandy texture, in places, which makes heavy fertilization necessary and results in poor coloring of the fruit; and lack of good air drainage in places. The Otisville soils have the same objectionable features as regards small areas and light texture. Many old orchards, high on the slopes of the Catskill Mountains, are planted on gravelly kames and outwash fans of the Otisville soils, but the climatic hazard in such areas is too great for commercial planting.

Lack of uniformity in depth constitutes the principal undesirable feature of the Cossayuna and Dutchess soils. Few areas, which do not include narrow ridges of shallow soil or rock outcrops, are sufficiently extensive for commercial orchards. Another drawback in some orchard areas on these soils is the presence of narrow poorly drained strips, but these are much less extensive than the shallow areas. Flat areas of heavy clay soils of both the Hudson and Schoharie series have been planted to apple orchards, but on these soils growth is slow, root diseases are common, yields are low, and the quality of the fruit is poor.

Peaches and cherries thrive best on the lighter (more sandy) soils. Pears, although they produce well on soils of medium or light texture, are more able to withstand less well drained conditions than apples or other fruits, except quinces. Grapes root deeply in favorable soils, but they return fair yields when planted on the shallow Dutchess and Nassau soils. These latter soils are also used extensively for currants, raspberries, strawberries, and other small fruits. To check erosion, however, the rows should conform to the contours of the slopes and not run up and down them.

Truck and garden crops require rich productive soils that hold moisture and retain fertilizers well, are easy to cultivate, and do not erode seriously. Extensive areas of such soils on the flood plains and in the valleys of Rondout, Esopus, and smaller creeks include Barbour silt loam, Barbour loam, and Barbour loamy sand; and in the Wallkill River Valley, Tioga silt loam. Of these, Barbour silt

loam, which in many places includes large areas of very fine sandy loam, is most extensively used for this purpose. At Kingston, near Kerhonkson, and elsewhere, large areas of this soil are used for a wide variety of market-garden crops, and good yields are obtained. Smaller areas of Tioga silt loam near New Paltz and in other places are used in the same way. Extensive additional areas of both these soils are available for such crops. In the valley of Esopus Creek also large areas of Barbour loamy sand, very little of which is used for market gardening at present, could be made into an excellent garden soil by heavy applications of manure and the plowing under of green-manure crops. Parts of some of these valleys are subject to occasional overflow. Since the construction of Ashokan Reservoir, this danger no longer exists in the Esopus Valley.

In this county there are no large areas of muck but numerous small ones, only a few of which have been drained and are used for market-garden crops. The depth and quality of muck seems good, and production is satisfactory.

West of Pine Hill, on Lackawanna silt loam and Culvers gravelly loam, large areas are devoted to cauliflower and smaller areas to brussels sprouts. It would seem that these soils, which occur at an elevation of 2,000 feet and higher in several places in the western part of the county, might be used to a greater extent for the production of cauliflower, brussels sprouts, lettuce, cabbage, and potatoes.

Most of the soils are moderately acid and are not adapted to the production of clover and alfalfa without the addition of lime. The reaction of the Hudson soils, however, is only slightly acid in the surface soil, and lime is abundant in the subsoil. These soils are extensively developed in the eastern part of the county. By using a small quantity of lime to sweeten the surface soil it is believed that red clover and alfalfa can be grown successfully to a much greater extent than at present. The Schoharie soils are also well supplied with lime in the lower part of the subsoil and can be used for the growing of clover and alfalfa, but they are not quite so well suited for this purpose as are the Hudson soils. Of the gravelly acid soils, the Cossayuna soils are least acid, and the fertile soils of this series can be made to grow clover successfully through the application of lime. Alfalfa can be grown if lime is applied in larger quantities. Alsike clover can be produced on many areas unsuited to the production of red clover.

The principal field crops of this county are those grown in connection with dairying and poultry raising, namely, alfalfa, timothy and clover, timothy, corn, oats, and wheat. The important vegetables grown for market are sweet corn, peas, beets, carrots, cabbage, tomatoes, and string beans.

Plowing for most crops is done in the spring, but plowing for corn usually is done in the fall. As tractors are used on comparatively few farms, most of the plowing is done with horse-drawn plows. Few riding cultivators are used; this, no doubt, is due to the rugged character of most of the county. The more common farm implements consist of one-horse cultivators; disk, peg-toothed, or spring-toothed harrows; and rollers.

A 5- or 6-year crop rotation is practiced, in which corn is planted 1 or 2 years, followed by small grains, 1 year of wheat and 1 year of oats, seeded to timothy and clover, or to alfalfa where the soils are

suit to this crop. In the 5-year rotation, wheat generally is omitted. A rotation followed by some farmers is as follows: 1 year of corn, followed by oats, seeded to timothy and clover, or to alfalfa which is cut for 3 or 4 years. Where suitable land is available, potatoes are planted 1 year followed by corn 1 year.

Commercial fertilizers are used to a very small extent. Growers who specialize in certain vegetables use most of the commercial fertilizer, which is a 5-10-5 grade, if no manure is used; or a 4-16-4 grade, if manure is used. A 5-8-7 fertilizer generally is used without manure. Barnyard manure supplies the nitrogen, and superphosphate supplies the necessary phosphorus for most of the common field crops. In the regular 5- or 6-year rotation, manure and superphosphate are applied before the corn is planted. From 8 to 10 tons of manure are used, with 40 to 50 pounds of superphosphate mixed with each ton of manure. Where phosphates are not mixed with the manure, from 400 to 500 pounds are added separately.

Lime requirements differ throughout the county. The upland soils of the western part are inherently strongly acid, and the lime requirement ranges from $1\frac{1}{2}$ to 2 tons per acre. Soils of the Hudson, Schoharie, Livingston, and Poygan series have a relatively low lime requirement, ranging from one-half to 1 ton. For all other soils the general lime requirement is approximately $1\frac{1}{2}$ tons. Lime is applied previous to planting oats with which clover, timothy, or alfalfa is seeded.

Where vegetables are grown on a very intensive scale, from 1,000 to 2,000 pounds of fertilizer to the acre is used. The average vegetable grower, however, uses from 500 to 600 pounds. Many vegetable growers use rye, vetch, or a combination of rye and vetch as a green manure. The green-manure crop is planted in the fall immediately after the vegetables have been harvested and is plowed under in the spring in preparing the soil for planting.

Average annual yields of the important crops are as follows: Alfalfa, 2 tons an acre; timothy and clover, $1\frac{3}{4}$ tons; timothy alone, $1\frac{1}{4}$ tons; silage corn, 7 tons; oats, 35 bushels; wheat, 25 bushels; and sweet corn, between 5,000 and 6,000 ears.

Fruit growing is the most important agricultural enterprise of the eastern part of the county, which lies in the Hudson Valley fruit belt. Nitrate of soda or cyanamid is applied at the rate of 2 to 6 pounds to the tree. Most orchards are left in sod or some other cover crop, which is cut and the cuttings used as a mulch. A few orchards are harrowed and a cultivated mulch maintained.

A study made in Ulster County by the agricultural economics and farm management department of New York State College of Agriculture, and others⁸ show that, on the average, the McIntosh yields more than any other variety of apple, and the Cortland variety ranks next. According to this authority, the McIntosh trees not only produced the most fruit, but McIntosh apples sold for the highest prices. In each year, 1933, 1934, and 1935, McIntosh returned more per acre than any other variety. In no one of the 3 years did the returns per acre from Stayman Winesap, Jonathan, Rhode Island Greening, or

⁸ SCOVILLE, G. P. APPLE YIELDS, PRICES, MARKETS, ULSTER COUNTY, HUDSON VALLEY, NEW YORK, 1933-1935. N. Y. Agr. Col. (Cornell) A. E. 180, 30 pp. July 1937. [Mimeographed.]

Wealthy amount to one-half as much as did the returns from McIntosh. The only variety to return each year more than one-half as much as McIntosh was Cortland.

A study of soil types and yields from McIntosh trees 15 years old and older was made, and the results are given in table 4.

TABLE 4.—Average yields of McIntosh apples from trees 15 years old and older on certain soils in Ulster County, N. Y., 1931-35

Soil type	Com- pari- sons	Yield of packed fruit—		Proportion of instances when bushels per tree were—			
		Per tree	Per acre	Less than 2	2 to 7	8 to 19	20+
Cossayuna gravelly loam (imperfectly drained) ¹	14	6.1	290	36	36	28	0
Nassau slate loam							
Cossayuna gravelly loam, shallow phase	62	7.2	323	8	55	37	0
Hoosic gravelly loam							
Hudson silt loam	204	12.2	450	3	27	57	13
Cossayuna gravelly loam (drained) ²							

New York Agricultural College (Cornell) A. E. 180, Apple Yields, Prices, Markets, Ulster County, Hudson Valley, New York, 1933-1935.

¹ Correlated Albia gravelly loam.

² Correlated Cossayuna gravelly loam, deep phase.

Since land is available in this county at a comparatively low price and New York City markets can be reached within a few hours by truck, it would seem that good opportunities exist for the expansion of fruit growing, market gardening, and the production of clovers and alfalfa, as well as for an increase in dairying.

FORESTS*

The early settlers found vast forests of pine, oak, beech, birch, maple, and other trees when they arrived in the area that afterward became Ulster County. There were a few clearings on the river flats where the Indians had located their villages and had grown corn, vegetables, and fruits. At present, approximately 65 percent of the entire county is forested. The forest consists chiefly of second-growth stands, most of the virgin timber having been cut for clearing of the land for farms, use in the local industries, and shipment. The forests and natural scenic beauty now attract many city dwellers and have led to the rapid development of summer resorts. Mountain-laurel, azalea, and rhododendron are very abundant in the western part of the county and add greatly to the natural beauty of the forests.

The Catskill Mountains in the western part of the county are largely covered by forests. A large area of these mountains lies within the State forest, the Catskill Forest Preserve. The forest cover may be divided into three types: (1) Sugar maple (*Acer saccharum*), beech (*Fagus grandifolia*), and yellow birch (*Betula lutea*) type; (2) hemlock (*Tsuga canadensis*) type; and (3) scrub or bear oak (*Quercus ilicifolia*) type.

* This discussion of the forests of Ulster County has been prepared by Wilber Secor, agronomy department, Cornell University Agricultural Experiment Station.

The sugar maple-beech-yellow birch type of forest is most extensive in this county. In places, in addition to these three varieties of trees, the cover includes smaller and different proportions of basswood or American linden (*Tilia glabra*), red maple (*Acer rubrum*), hemlock, red oak (*Quercus borealis*), white pine (*Pinus strobus*), black cherry (*Prunus serotina*), sweet birch, locally called black birch (*Betula lenta*), American elm (*Ulmus americana*), balsam fir (*Abies balsamea*), and red spruce (*Picea rubra*). At higher elevations red spruce becomes more dominant, yellow birch disappears, and the cover approaches a red spruce-sugar maple-beech type.

In many places the hemlock type of cover is intermingled with the sugar maple-beech-yellow birch type, but, in most places, hemlock grows in cooler locations than the sugar maple-beech-yellow birch type, as in moist ravines and on north slopes. Its associates are beech, sugar maple, yellow birch, black birch, basswood, red maple, black cherry, balsam fir, and white pine.

The Catskill soils in the eastern part of the Catskill Mountains are covered with bear oak and its associates. Owing partly to fires, frequent cuttings, and shallow soil, most of the species in this type of forest have a very scrubby and abnormal appearance. In places, bear oak grows in pure stands, but in most places it predominates in mixed stands with black oak (*Quercus velutina*), chestnut oak (*Q. montana*), red oak, white oak (*Q. alba*), sugar maple, red maple, and sassafras (*Sassafras variifolium*).

The forested areas of the eastern part of the county may be separated into three divisions, the Shawangunk Mountain area, the Marlboro Mountain area, and the lowland areas. The soils of the Shawangunk Mountains are in general shallow or poorly drained. This feature, together with the occurrence of severe fires, is conducive to slow and irregular growth of the forest. The sugar maple-beech-yellow birch type is the principal type of forest cover in this area. Red spruce and balsam fir do not occur as associate species. Sassafras, however, grows nearly everywhere throughout this section. Pitch pine (*Pinus rigida*) grows in pure stands, especially around Sams Point. It is very stunted here, and few trees reach a height of more than 5 feet. In other places, it is the predominant species, with associates of chestnut oak, black oak, chestnut (*Castanea dentata*), and sassafras.

Trees of a greater number of species grow on Marlboro Mountain than elsewhere in the county. The sugar maple-beech-yellow birch type, previously described, and a type of forest consisting of white, black, and red oaks are the two important ones on this mountainous area. Associated with both types are shagbark hickory (*Carya ovata*), white ash (*Fraxinus americana*), black cherry, butternut (*Juglans cinerea*), largetooth aspen (*Populus grandidentata*), American elm, red maple, basswood, black locust (*Robinia pseudoacacia*), and tuliptree or yellow poplar (*Liriodendron tulipifera*). A third type of forest cover recognized in this section, but of less importance, consists of American elm, red maple, and black ash. Within this section, as well as in the lowlands, this type of forest grows on moist soils in small depressions, swamps, muck areas, and sluggish stream basins, generally in association with the other types.

The forests in the lowlands grow in small areas on abandoned farms, steep slopes, poorly drained areas, or in farm wood lots. The

sugar maple-beech-yellow birch and the American elm-red maple-black ash types, both described previously, together with the eastern red cedar (*Juniperus virginiana*) and the white pine types, are common in the lowlands. The forest cover on soils underlain by limestone and calcareous sandstone is of the eastern red cedar type. The red cedar rarely grows in pure stands but is predominant over its associates of red maple, black birch, largetooth aspen, black locust, black oak, white oak, and American elm. White pine grows on both light- and heavy-textured soils but has different associates on each type of soil. On the light soils with rolling relief white pine grows, in a few places, in pure stands, but, in most places, it is associated with red pine, largetooth aspen, pitch pine, and white oak. On the heavier soils there is a greater admixture of species, and the white pine dominates its associates, which include red oak, largetooth aspen, sassafras, black locust, black birch, yellow birch, black cherry, basswood, hemlock, and yellow poplar.

PRODUCTIVITY RATINGS

In table 5 the soils types, phases, and miscellaneous land types are rated according to their productivity for each of the important crops grown and according to their general productivity. They are listed in the order of their general productivity under prevailing farming practices, which include the use of amendments.

TABLE 5.—*Productivity rating of the soils of Ulster County.*

Soil ¹	Crop productivity index ‡ for—										
	Corn (grain)	Corn (silage)	Oats	Wheat	Buck-wheat	Tame-grass hay	Red clover	Alfalfa	Pota- toes	Cab- bage	Tom- atoes
Tioga silt loam *	80 (95)	90 (100)	70 (90)	60 (80)	60	90	70 (90)	35 (50)	30 (60)	60 (70)	60 (70)
Barbour silt loam *	70 (85)	80 (90)	70 (90)	50 (75)	60	80	65 (85)	30 (45)	30 (60)	60 (70)	60 (70)
Tioga fine sandy loam *	70 (85)	80 (90)	60 (80)	50 (70)	60	80	60 (80)	25 (40)	30 (60)	50 (60)	60 (70)
Hudson silt loam	60 (80)	60 (80)	60 (80)	50 (70)	60 (70)	60 (80)	60 (80)	30 (50)	40 (60)	60 (80)	50 (60)
Barbour loam *	60 (80)	70 (85)	60 (80)	50 (70)	50	70	60 (80)	15 (35)	30 (60)	50 (60)	50
Cassadya gravelly loam, deep phase	50 (70)	50 (70)	50 (70)	50 (70)	60	50 (70)	50 (70)	(45)	40 (60)	40 (60)	50 (60)
Cassadya gravelly loam	50 (70)	50 (70)	50 (70)	50 (70)	50	50 (70)	50 (70)	(40)	40 (60)	40 (60)	50 (60)
Hudson very fine sandy loam	50 (70)	50 (70)	50 (70)	40 (60)	50 (60)	50 (70)	60 (80)	(45)	50 (60)	50 (70)	50 (60)
Muck (drained)	40 (60)	40 (60)	50 (70)	40 (60)	40 (60)	40 (60)	40 (70)	---	---	---	---
Hosic gravelly loam	30 (50)	40 (60)	50 (70)	40 (60)	50 (60)	50 (60)	40 (60)	(40)	30 (50)	40 (60)	50 (60)
Boynton silt loam (drained)	40 (60)	40 (60)	50 (60)	40 (60)	50	50 (70)	40 (70)	(15)	30 (50)	50 (70)	30 (40)
Farmington gravelly loam †	30 (60)	30 (60)	50 (60)	40 (60)	50	50 (70)	40 (70)	(35)	40 (60)	50 (70)	40 (60)
Dutchess gravelly loam	30 (60)	30 (60)	50 (60)	50 (60)	50 (70)	40 (60)	40 (60)	(30)	30 (50)	40 (60)	40 (60)
Hudson silty clay loam	40 (60)	50 (70)	50 (70)	40 (60)	50	50 (60)	40 (60)	(40)	40	50	50
Schoharie silty clay loam	40 (60)	40 (60)	50 (60)	40 (60)	50 (60)	50 (70)	50 (70)	(35)	30 (40)	50 (70)	30 (40)
Lackawanna silt loam	30 (60)	30 (60)	50 (60)	40 (50)	50 (60)	40 (60)	40 (60)	(30)	50 (60)	50 (70)	50 (60)
Orono silty clay loam (drained)	40 (60)	50 (70)	50 (70)	40 (50)	50 (60)	50 (60)	40 (60)	10	20 (40)	50 (70)	20
Tunkhannock gravelly loam	40 (60)	40 (60)	40 (70)	40 (60)	50 (70)	50 (70)	40 (60)	(30)	30 (50)	40 (60)	40 (60)
Agawam sandy loam	30 (40)	30 (40)	30 (50)	30 (40)	40 (50)	40 (60)	30 (50)	(30)	20 (40)	30 (50)	40 (60)
Hudson silt loam, rolling phase	30 (50)	30 (50)	40 (60)	30 (50)	40	40 (60)	50 (70)	(35)	30 (40)	40	30
Barbour loamy sand *	30 (50)	30 (50)	30 (40)	30 (40)	40	40 (60)	40 (60)	(30)	40 (50)	30	50
Middlebury silt loam	30 (50)	30 (50)	30 (50)	30 (40)	40	60 (70)	30 (50)	(15)	30 (40)	40 (60)	30
Watson gravelly silt loam †	30 (50)	30 (50)	30 (50)	30 (50)	40	40 (60)	30 (50)	(15)	40 (50)	40 (60)	30 (40)
Otseville gravelly loam †	20 (30)	30 (40)	30 (40)	20 (30)	40	30 (50)	20 (50)	(15)	30 (40)	20	30
Albion gravelly loam	30 (40)	30 (50)	30 (50)	30 (40)	40	40 (60)	30 (50)	(15)	30 (40)	30 (50)	30 (40)
Culvers fine sandy loam	30 (50)	30 (50)	30 (50)	30 (50)	40	40 (60)	30 (50)	(15)	30 (50)	30 (40)	30 (40)
Braceville silt loam *	40	50	30	30	30	50	50	(15)	30	40	30
Agawam loamy fine sand	30 (50)	30	30 (40)	30 (50)	40	30 (40)	30 (50)	(25)	30 (40)	20 (30)	30 (40)
Merrimac gravelly sandy loam	30 (40)	30 (50)	30 (50)	30 (40)	30	40 (50)	30 (40)	(15)	30 (40)	30	30 (40)
Culvers gravelly loam	30 (50)	30	40 (60)	30 (50)	40	40 (60)	20 (50)	(15)	30 (40)	30 (40)	30 (40)
Basher silt loam *	40	40	40	30	40	50	20	---	20	30	20
Hudson silt loam, imper- fectly drained phase	30	30	30	30	30	50	10 (20)	---	10	20 (30)	10 (20)
Cassadya sandy loam †	20 (30)	20 (30)	20 (30)	20 (30)	30	20	30	---	---	---	---
Tunkhannock gravelly loam, rolling phase	20 (30)	---	---	---	---	---	---	---	---	---	---
Cassadya gravelly loam, shallow phase †	20 (40)	---	---	---	---	---	---	(10)	30	20	30

The rating compares the productivity of each of the soil types or other mapping units in the county for a given crop to a standard, which represents the approximate average yield obtained without use of amendments on the more extensive of the better soil types of the section in which the crop is most widely grown. The standard is given an index of 100. A soil estimated to be about half as productive for the specified crop as a soil with the standard index receives an index of 50. A few unusually productive soils of limited acreage have an index above 100 for a specified crop.

The following tabulation gives the more important crops of the county and the acre yield that has been set up as a standard of 100 for each crop. These yields represent long-time production averages on the better soils of significant acreage in the United States for products of satisfactory quality obtained without the use of soil amendments other than those produced directly or indirectly by the soil.

Crop:

Corn (grain)-----	bushels--	50
Wheat-----	do----	25
Oats-----	do----	50
Buckwheat-----	do----	25
Potatoes-----	do----	200
Apples-----	do----	200
Corn (silage)-----	tons--	12
Timothy-----	do----	2
Clover-----	do----	2
Alfalfa-----	do----	4
Cabbage-----	do----	12
Tomatoes-----	do----	12
Pasture-----	cow-acre-days ¹ --	100

¹ Cow-acre-days is a term used to express the carrying capacity of pasture land. It is the product of the number of animal units carried per acre multiplied by the number of days the animals are grazed without injury to the pasture. For example, a soil type able to support 1 animal unit per acre for the entire year rates 365, whereas another soil able to support 1 animal unit on 2 acres for 180 days of the year rates 90. Again, if 4 acres of pasture support 1 animal unit for 100 days the rating is 25.

The productivity indexes are based on the ability of the land to produce under two levels of management—dominant current practices and farming without use of amendments. Under the dominant current farming practices in Ulster County, amendments, such as lime, phosphate, and complete commercial fertilizers, are commonly used. The use of manure produced on the land is not considered an amendment. On some lands a lower level of management is practiced—very largely without amendments. The first index shows this production without amendments and the second index, in parentheses, shows the productivity of the soil with amendments.

The principal natural factors influencing the productivity of land are climate, soil, and relief, or lay of the land. All are concerned in the determination of the productivity ratings, and low ratings for a particular crop may as likely be due to an unfavorable climate or unsuitable lay of the land as to lack of fertility in the soil. As long-time crop yields furnish the best available summation of the factors contributing to soil productivity, they have been made the basis, so far as such information is available, for the determination of the indexes.

In a number of instances of soils with poor natural drainage, two sets of indexes are given, one applying to areas with no artificial

drainage, the other to areas to which most favorable artificial drainage has been applied. In many instances some artificial drainage, but not the most favorable, has been applied to poorly drained lands so that their inherent productivity under the best drainage is not realized. The cost or difficulty of providing drainage plays no part in the productivity rating of such lands. Two kinds of soil having the same productivity when drained are rated the same, although adequate artificial drainage may cost 10 times as much on one as on the other. In certain instances, however, a lack of information may preclude the giving of any rating other than for the natural condition.

Land on the flood plains or bottoms is subject to occasional overflow, but this seldom does great damage to crops. For this reason only one set of ratings is given for the alluvial soils, and that is for crop yields under favorable conditions.

The soils are listed in the order of their general productivity under the prevailing current practices as determined by the weighted average of the crop indexes in parentheses. The weighted average has been based both on the areal extent of the individual crops and their comparative total value.

The marked differences in the suitabilities and uses of different soils because of different climatic and drainage conditions and different soil characteristics makes it inadvisable to use a uniform set of weightings of crop indexes to determine the general productivity grades of all the soil types. Instead, separate weightings of crop indexes are set up for each of seven general conditions, as indicated in table 6.

TABLE 6.—*Percentage weights given to crop indexes to aid in the determination of the general productivity grades*

Crop	Well-drained arable soils of the—					Imper- fectly and poorly drained arable soils	Grazing and forest land
	Rolling uplands	Moun- tain areas	Terraces		Bottoms		
			Sandy and gravelly	Silty and clayey			
Corn (grain).....	5	5	3	10	10	5	-----
Corn (silage).....	5	5	5	10	10	5	-----
Oats.....	5	10	2	5	5	5	-----
Wheat.....	2	2	2	4	2	3	-----
Buckwheat.....	1	1	1	1	1	3	-----
Tame-grass hay.....	30	30	20	20	25	40	-----
Red clover.....	10	10	10	15	20	10	-----
Alfalfa.....	5	1	5	10	8	0	-----
Potatoes.....	5	15	3	5	5	3	-----
Cabbage.....	2	10	1	2	2	2	-----
Tomatoes.....	2	1	1	3	2	1	-----
Market-garden vegetables.....	3	5	2	5	5	3	-----
Apples.....	20	0	35	5	0	0	-----
Permanent pasture.....	5	5	10	5	5	20	25
Total.....	100	100	100	100	100	100	25

As it is difficult to measure mathematically either the exact significance of a crop in local agriculture or the importance and suitability of certain soils for particular crops, these weightings for indexes are used only as guides. Certain modifications in the general ranking of the soils according to personal judgment are allowed.

In addition to listing the soils in the order of their general productivity according to prevailing farm practices, productivity grade numbers are assigned in the two columns, under General productivity grade, according to Current practices and Without amendments. These are based also on the weighted average of the crop indexes. If the weighted average falls between 90 and 100, the soil type is assigned a grade of 1; if the weighted average falls between 80 and 90, a grade of 2 is given, etc. The column, Land classification summarizes and compares the principal aspects of productivity and use of each soil.

Although a soil may be the most productive in a county or section, it does not necessarily receive a rating of 1, since that rating is given only to those soils given a weighted average of 90 or more. For example, Tioga silt loam is the most productive soil in Ulster County, but the weighted average of its productivity under current farming practices, which include the use of amendments, is 82.8 percent. Therefore, it is rated 2 for this system of farming.

Productivity tables do not present the relative roles which soil types, because of their extent and the pattern of their distribution, play in the agriculture of the county. The tables give a characterization to the productivity of individual soil types. They cannot picture the total quantitative production of crops by soil areas without the additional knowledge of the acreage of the individual soil types devoted to each of the specified crops.

It should be emphasized that these productivity ratings cannot be interpreted directly into land values except in a very general way. Other factors—geographic, economic, and social—have great influence in determining land values. Among these are distance to market, transportation facilities, relative prices of farm products, and many others.

MORPHOLOGY AND GENESIS OF SOILS

Ulster County lies chiefly within the belt of Gray-Brown Podzolic soils of the United States. The entire area originally was heavily forested, and much of it at present is covered by second growth. A podzolic profile has been moderately developed in the soils. This consists of a thin layer of partly decayed leaves, a dark-brown or nearly black highly granular layer to a depth of about 5 inches, a brownish-gray sandy layer to a depth of 12 inches, and a yellowish-brown or reddish-brown subsoil. In cleared and cultivated areas, these surface layers have been mixed, but traces of them may be found in almost any wood lot.

This section is one of numerous hills and of steeper mountain slopes. Therefore, material frequently is removed from the surface by erosion, especially in the cleared and cultivated areas, and the soils are being rejuvenated. They are, therefore, closely related to the underlying parent material.

Much of the area has been glaciated, the glacial mantle over the larger part being thin and closely related to the underlying formations, which consist of thick-bedded to massive calcareous sandstone, predominant in the eastern part of the county, which has had an influence in the development of the Cossayuna soils; beds of slate and shale in the southeastern part and in a few other places, which have

influenced the development of the Dutchess and Nassau soils; massive beds of nearly pure limestone extending from near High Falls through Stone Ridge, Rosendale, and Kingston to the northeastern corner of the county, which has been a factor in development of the Farmington soils; a nearly white crystalline conglomerate, which has been important in the development of the Albia soils; bluish-gray hard thin-bedded sandstone, slightly calcareous in places, which has influenced the formation of the Catskill soils; and gray and red thin-bedded sandstone and a dull-red soft slate, which have been important in the development of the Culvers, Lackawanna, and Walton soils. Soils of all of these series have developed from gravelly and stony material and are, in general, shallow, gravelly, and stony. The depth of soil and content of stony material are important factors in their utilization.

The following description of a profile of Cossayuna gravelly loam in a forested area is representative of the normally developed soil of the section included in the Gray-Brown Podzolic soil region:

1. 0 to 2 inches, forest litter underlain by a very thin layer of dark-gray or dark grayish-brown leafmold.
2. 2 to 9 inches, dark grayish-brown finely granular gravelly loam. The gravel consists largely of small sharp pieces of calcareous sandstone but includes shale and slate also. The pH value is 5.5.
3. 9 to 12 inches, light-brown or slightly grayish brown gravelly friable loam having a small cloddy structure. The pH value is 5.0.
4. 12 to 24 inches, light gravelly loam, rather silty in texture, slightly compact, and gravelly. The reaction of the material in this layer is pH 6.0.
5. 24 to 36 inches, light-brown or slightly reddish brown very gravelly loam, in which the gravel fragments are not only more abundant but also larger than in the overlying layer. The pH value is 6.5.

Weathered gravel and stone fragments are brown on the outside, but when broken the larger ones are found to be gray in the interior. This gray material effervesces freely on the application of acid.

Each soil also is influenced by drainage or the lack of it. Well-drained soils have a brown, dark-brown, or reddish-brown surface soil and a slightly lighter tint of the same color in the subsoil. Imperfectly and poorly drained soils have a dark surface soil, a lighter colored upper subsoil layer, which is strongly mottled with yellowish brown or rusty brown in the lower part, and a less mottled lower subsoil layer.

The Wurtsboro soils are true Podzols, whereas the Culvers, Albia, and Walton soils are Brown Podzolic soils. They all have compact layers in the subsoil. There is no such layer or only a slight development of it in the Cossayuna, Dutchess, and Nassau soils.

Following is a description of a typical profile of Wurtsboro gravelly sandy loam:

1. Matted leaf litter and a fine-crumb black mull, with a maximum thickness of 1 inch.
2. A 3-inch layer, the leached zone, of light-gray or whitish-gray structureless very porous stony sandy loam.
3. Deep-yellow mellow fragmental gravelly loam about 7 inches in maximum thickness.
4. Firm to compact lumpy yellowish-brown gritty silt loam slightly stained with yellow and rust brown, with a maximum thickness of 7 inches.
5. Light-brown compact platy gritty silt loam highly mottled with yellow, light gray, and rust brown, nearly 6 inches in thickness.

6. Very compact hard dark-brown gritty silt loam, with light-gray coatings stained with yellow along breakage planes. This layer ranges in thickness from 8 to 12 inches.
7. Very compact hard dark-brown gritty silt loam glacial till with a rather cloddy structure.

In different areas of this soil, the texture ranges from sandy loam to loam; the relief is rolling to rather steep; surface drainage is good, but internal drainage is imperfect; and the vegetation consists of hardwoods, together with some white pine and pitch pine. Most of the hardwoods are oaks. Some chestnuts with a few sassafras, soft maple, white ash, and tulip tree are intermixed. The undergrowth is mountain-laurel, huckleberry, and wintergreen.

The reaction of Wurtsboro gravelly sandy loam ranges from about pH 5.0 in the surface soil to pH 6.5 in the lower part of the subsoil.

It seems probable that the Culvers soils are more largely developed from residual material than are the soils previously described. A representative profile of a Culvers soil is as follows:

1. 0 to one-half inch, dark-brown leafmold.
2. One-half to 2 inches, dark-brown fine sandy loam.
3. 2 to 18 inches, brown or slightly reddish brown gravelly fine sandy loam.
4. 18 to 30 inches, light yellowish-brown very compact fine sandy loam, which contains some gravel consisting largely of thin plates of gray fine-grained sandstone, together with some red sandstone.
5. 30 to 60 inches, reddish-brown and gray slightly mottled gravelly fine sandy loam, less compact than the material in the layer above.

The pH values for this soil range from 4.5 or 5.0 in the surface soil to about 6.0 in the lower part of the subsoil.

The soils of the Hudson and Schoharie series, which are developed on the terraces, owe the coloring of the lower subsoil layer and their alkalinity to the character of the parent material. The color of the surface soil has been changed by the processes of soil development to light brown or yellowish brown in the Hudson soil and to pale reddish brown in the Schoharie. The same material that develops, under conditions of favorable drainage, into the Hudson soils, develops, under conditions of imperfect or poor drainage, into the Livingston soils with their black surface soils and mottled subsoils. Likewise, the material which develops, under conditions of favorable drainage, into the Schoharie soils, develops, under conditions of imperfect or poor drainage, into the Poygan soils.

A profile of Hudson silt loam may be described as follows:

1. 0 to 10 inches, brown or slightly yellowish brown finely granular light-textured silt loam. Below a depth of 3 inches the material is more coarsely granular and is more pronounced yellowish brown than it is above that depth.
2. 10 to 18 inches, pale-yellow heavy silt loam or silty clay loam, which breaks into sharp hard clods ranging from one-fourth to three-fourths inch in diameter. The material is very slightly mottled with gray and rusty brown in the lower part.
3. 18 to 24 inches, pale bluish-gray and lighter gray clay, which breaks into hard sharp clods from one-half to 1 inch in diameter.
4. 24 to 60 inches, bluish-gray blocky clay, which effervesces freely on the application of acid.

The chemical reaction of Hudson silt loam ranges from about pH 4.5 at the surface to pH 7.0 at a depth of 30 inches.

Hoosic gravelly loam is representative of the soils developed on the more gravelly terraces. A typical profile as observed east of Modena is as follows:

1. 0 to 10 inches, grayish-brown loam containing a moderate quantity of small water-worn gravel, much of which is slate and shale.
2. 10 to 24 inches, light-brown loam slightly heavier in texture and more compact than the surface soil.
3. 24 to 36 inches, light yellowish-brown very friable gravelly loam.
4. 36 inches +, coarse sand and fine sharp gravel, in which are some layers of large water-worn gravel.

Alluvial soils of the stream flood plains are greatly influenced by the character of the parent material and by the conditions under which it has weathered. The dark-brown Tioga soils have been developed, in part, from material eroded from dark-colored slates and shales. The red Barbour soils, on the other hand, have developed to a larger extent from material eroded from red sandstone and from deep-red slate and shale. The poorly drained conditions under which the Holly and Mansfield soils have developed have had a dominating influence on them and have obscured the color of the parent material. These soils have accumulated much organic matter in the surface soils, which are dark gray.

SUMMARY

Ulster County is situated in the southeastern part of New York along the western side of Hudson River. From the river it extends westward including Marlboro Mountain, the northern part of the Shawangunk Mountains, and the southern part of the Catskills. In these sections much of the land is too steep and stony for cultivation but parts are well suited for forestry, for summer homes, and for recreational purposes. Including these mountainous areas, uncleared wood lots, abandoned farms, and poorly drained areas, it is estimated that nearly 65 percent of the area of the county supports a forest growth. Throughout a considerable proportion of the rest the land is hilly, stony, or of low fertility.

Settlement of this section began at an early date. The first settlers were largely Dutch people and French Huguenots, of whom many residents of the county are descendants. Ulster was one of the original or "mother" counties of New York. The first State constitution was adopted at Kingston in 1777.

The early settlers cleared and farmed not only the valley lands, the terraces, and lower hills, but they gradually extended their clearings until they covered steep and stony hill and mountain slopes. From these a part of the stones were picked and built into stone fences, at an enormous expenditure of labor, and the land was cultivated or pastured. Small orchards were planted, and farm homes were established far back in the mountains. Many old stone houses, built before the Revolutionary War, are still in use.

An important change in the composition of the population has taken place during recent years. Some farms have been sold to people of Italian or of other European birth or descent, and many farm sites have been converted into summer boarding houses for people from the cities.

Important changes have occurred also in the agriculture during the last 50 years. Less than one-half as much land now is devoted to general farm crops, other than grass and hay, as was used for this purpose 50 years ago, and many farms in the rougher sections are entirely abandoned and made a part of the Catskill Forest Preserve or incorporated into large private estates.

Fruit growing, dairying, and poultry raising, on the other hand, have increased. These occupations, however, are confined largely to the valleys and less hilly lands in the eastern and southeastern parts of the county.

The soils of the county are placed in three groups. The first group comprises soils of the uplands, hills, and mountains developed from stony and gravelly glacial till and residual material, which are comparatively shallow over bedrock. Of these the Cossayuna, Dutchess, Culvers, and Lackawanna soils are the most important. The second group is composed of soils of the terraces and outwash fans and developed from stratified water-laid materials. The Hoosic and Otisville soils have subsoils of sand and rounded gravel, and the Hudson and Schoharie soils have subsoils of calcareous clay. The Hoosic soils are used extensively for orchards and the Hudson soils are well suited to the production of clover, alfalfa, and other legumes. The third group includes soils of the flood plains and of low-lying imperfectly and poorly drained areas. Brown and reddish-brown soils occupy the best drained parts of the large stream valleys and gray imperfectly and poorly drained soils occupy other parts of the larger valleys, nearly all of the smaller valleys, and other areas and slopes. The brown and reddish-brown soils, where deep, are highly productive and are used both for general-farm crops and for market-garden crops. These belong to the Tioga and Barbour series. The imperfectly and poorly drained soils have dark-gray surface soils and light-gray subsoils strongly mottled with yellowish brown. Their agricultural value is very low. The most extensive of these soils belong to the Holly and Mansfield series. The fourth group comprises miscellaneous land types that have little agricultural value except for forestry and pasture.

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